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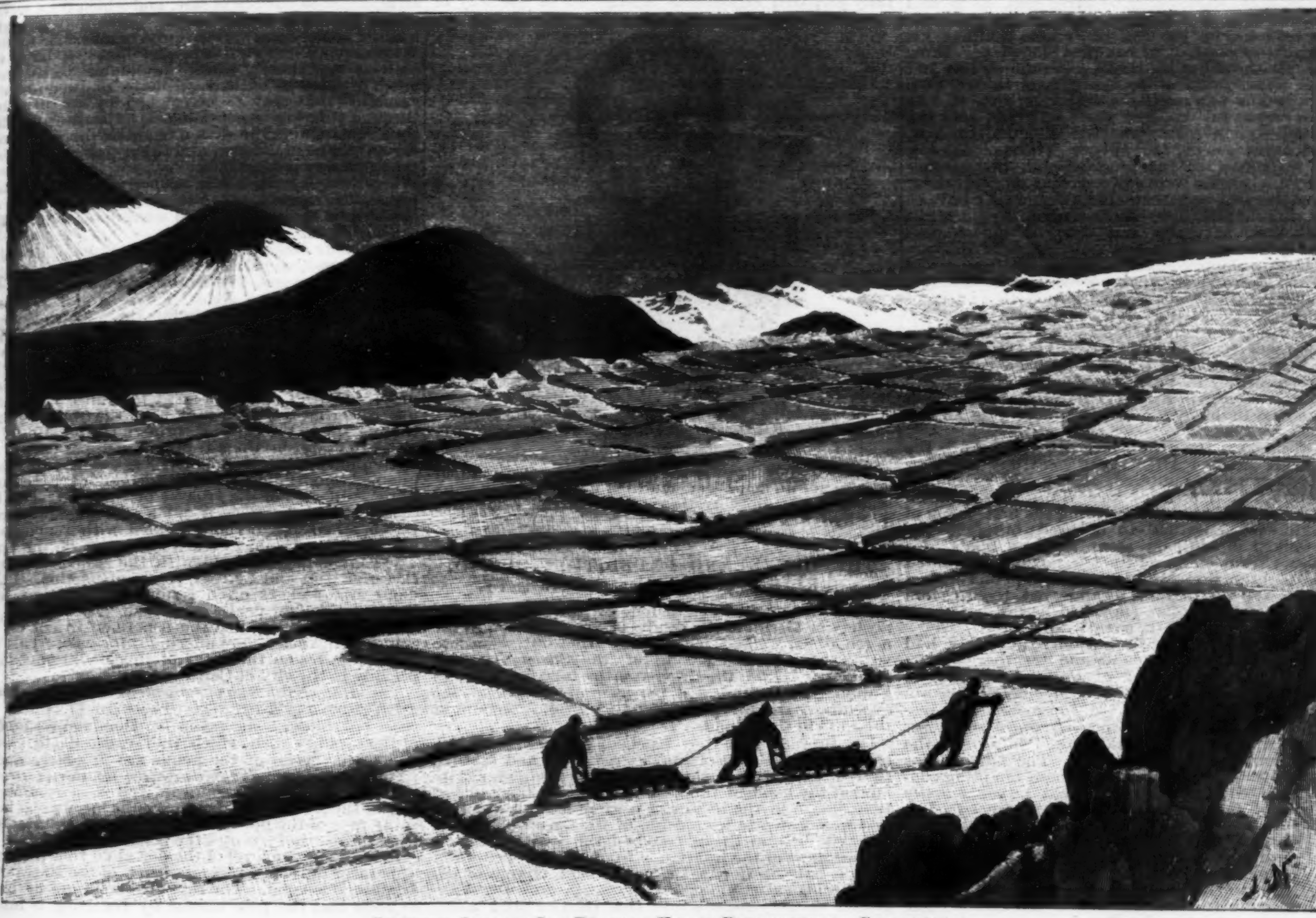
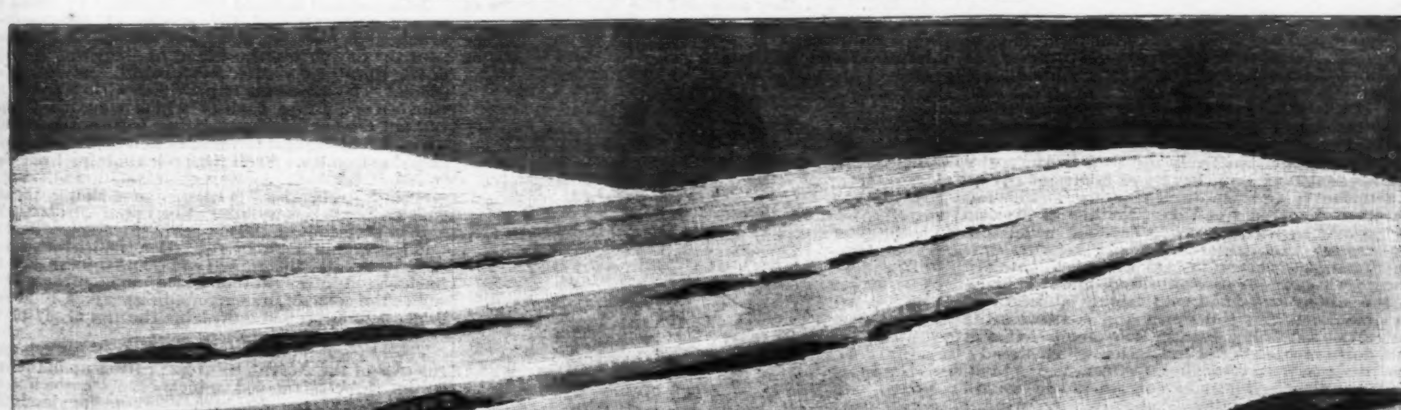


CROSSING INLAND ICE BROKEN UP BY RECTANGULAR CREVASSES.



LIEUT. GARDE'S EXPEDITION ACROSS GREENLAND—CROSSING AN UNDULATING PLATEAU OF INLAND ICE FULL OF FISSURES.—(From sketches by Lieut. Garde.)

THE EXPLORATION OF GREENLAND.

LIEUTENANT T. V. GARDE, of the Royal Danish Navy, who last spring was dispatched to survey the west coast of Greenland, having returned to Copenhagen, gives in his official report some very interesting details of his remarkable march on the inland ice plateau in the company of only two companions, Lieutenant Count Carl Moltke and the interpreter Johan Petersen. It should be pointed out that this exploration was really no part of Garde's official programme, and that he was in no way equipped for such an undertaking. It was, in fact, a "summer trip" on this almost unexplored icy continent. All three young men had taken part in Captain Holm and Lieutenant Ryder's celebrated expeditions along the east coast.

The little expedition started from the Sermitsialik Glacier, lat. 61 deg. N. Lieutenant Garde had decided that there should only be three men, as he had only two sledges, each with a load of 180 pounds. He had to be back by the end of June to continue his survey of the coast, but was provisioned for three weeks. By the aid of his boat's crew, the sledges and baggage were carried up to the edge of the ice, 1,300 feet above the sea, on the morning of June 16. At 10:30 the parties said good-by to each other, and the expedition began to march in a direction of N.E. by ¼ E., the ice being fairly good. The copious snow on the surface aided the progress, and, the weather being cool, six miles were covered that day. It then, however, became apparent that they would have to march at night and sleep in the day, a most difficult task at first, naturally, but only by this arrangement they succeeded, in the short space of thirteen days, in covering some 200 miles, or halfway across Greenland, never hitherto explored in this latitude. At night there was generally from 20 to 40 deg. of frost Celsius, so that the snow was hard. About fifteen miles inland the ice became more even. Garde's intention was to proceed at first as far as possible in the direction stated, but to march back in a more easterly direction in order to visit the "Nunatak" (lofty peaks rising above the ice) Aputajuitsok, which is considered to be the northernmost outpost of the Julianehaab Alps.

For eight days the party tramped northward, the snow being good. After the second day no more waterpools were encountered, the ice plateau sloped gently upward. The snow was virgin white, soft in the day, but hard at night. During the first hours of the night snowshoes had to be used; otherwise the party walked in ordinary stout laced-up boots. No "Nunatak" was seen, and the icy snowfield presented but a slightly undulating surface, and on the last two days the undulation disappeared too. Before them lay the endless flat snowfield as far as the eye could reach—north, south, east, west.

On June 22 (the seventh day out) the party had reached about 110 miles inland, and was, therefore, in the latitude of the Colony of Frederikshaal. The change anticipated in the landscape here being absent, Garde decided, on the 23d, to proceed some distance due east, and then shape his course southeast for the Aputajuitsok "Nunatak;" however, the snowfield remained perfectly level. The altitude was now about 7,000 feet. In spite of these tempting conditions, and the apparent fact that he *could easily have crossed the Greenland continent from west to east*—a feat never hitherto achieved in that altitude, Garde decided that his duty was rather to reconnoiter Aputajuitsok, and to ascertain the conditions of the ice around this peak. It was clear that the spur of the Greenland continent had been obtained, and the route to the east coast lay before the explorer like a macadamized highroad But duty demanded his return.

In proceeding south the lofty "Nunatak" presently came in view, and it was reached on the 26th. Several smaller "Nunataks" were found grouped around the greater one, the whole forming a wild Alpine landscape with glaciers, rising above the ice-covered continent. It was anticipated that huge accumulations of ice and moraines would be found screwed up against the peaks, but such was not the case; the ice stretched evenly and uniformly right up to the rocky walls, thus demonstrating that there is apparently no motion in the inland ice in the interior. This has been a much disputed question. Neither of the two highest peaks appeared ascendable; but a smaller one was ascended, and observations and measurements taken. To the northeast several other "Nunataks" were seen; while to the east appeared, like in a panorama, the whole grand and wild Alpine landscape of South Greenland. To the south and southwest the ice plateau sloped fairly evenly; but much cleft and fissured down into the Sermilik Glacier, which already, in an altitude of from 3,600 to 4,000 feet, begins to fill the valleys, although it does not reach the sea till some fifteen or twenty miles further on. Lieutenant Moltke got his camera out here and obtained some good views of these rugged parts on which no human eye had rested before. Probably the flow of the Sermilik Glacier is the chief cause of the ice lying so evenly inland around these "Nunataks."

The route back lay along the north shore of the fjord Ikersuak. Here the ice was very much rent and dangerous. The route ran from W.S.W. to N.N.W. On June 28, the final day of the wanderings, fifteen miles were covered, the last seven or so being almost impassable through the broken state of the ice. Land was reached only two miles to the west of calculations, and after the fatiguing fortnight, the delight of sleeping on the soft green heather may be better imagined than described. The next morning Garde's crew espied his tent and came to render assistance, and at night the party reached the Esquimo trading station Kagsimiut, safe and sound. The weather was fine nearly the whole time. The effect of the sun on the snow was grand to behold, and quite a surprise. Even at an altitude of from 5,000 to 6,000 feet, water could be pressed copiously from the snow in the middle of the day. On two nights only were they weather bound, *i. e.*, in an altitude of about 6,000 feet, where they were caught in a terrific snowstorm from E.N.E., with several degrees of frost—a storm the like of which none of the party had ever met with in Greenland. Curiously enough, coincident with this storm, a strong "Fohn," or soft, warm wind, blew on the coast. Throughout the whole journey meteorological observations were regularly made, while simultaneously the barometer was read at the camp on the shore by the steersman, a very intelligent Greenlander.

Although we know that Nansen crossed Greenland in a higher latitude (lat. 65 deg. N.) in 1888, and that Nordenskjold twice, in 1870 and again in 1883, made incursions on the inland ice, covering about 200 miles, not to mention Peary and Maigaard's remarkably successful expedition in 1878, in lat. 78 deg. N., when he reached some 350 miles inland—it should be borne in mind that all these expeditions were carefully planned and equipped for the purpose in view, whereas with the Garde party such was not the case. Nevertheless, here is the fact that the three young and intrepid students of science venture boldly upon an undertaking that would have appalled many a stout Arctic *voyageur*, and accomplish as much as the carefully prepared expeditions referred to in the way of

LIEUTENANT T. V. GARDE.
(Of the Royal Danish Navy.)

adding to our knowledge of the vast mystic Polar continent—an achievement which may certainly rank among the leading Arctic ventures of the century.—*The Graphic, London.*

THE GREENLAND EXPEDITION OF THE BERLIN GEOGRAPHICAL SOCIETY.

PARTICULAR interest is felt by the Geographical Society of Berlin in the results of an expedition to the north of Greenland, which they fitted out some two years ago. At the sitting of the Society held on November 4, 1893, Dr. Erich von Drygalski and Dr. E. Vanhoffen communicated papers on the work of the expedition, Dr. Drygalski giving a general account of their life in Greenland.

On June 27, 1892, they reached Umanak, a Danish colony on the shores of North Greenland, and selected as their base of operations a position some distance inland at the head of the Umanak Fjord. They placed their house in the hollow of a great ice cirque. East and west were the ice streams of the Great and Lesser Karajak, behind them stretched the bare expanse of the ice sheet of the interior, in front lay the open water of the narrow fjord. Dr. Stade had charge of the meteorological station; Dr. Drygalski and Dr. Vanhoffen made journeys into the interior and along coastal regions of glacier and moraine.

At first, when they ascended the Karajak, none of the Greenlanders were willing to accompany them, as they are full of superstitions about the ice wastes of the interior. Three ultimately consented, and overcame

LIEUTENANT COUNT CARL V. MOLTKE.

their fears so far as to enter with spirit into the difficulties of the tour. Bamboo canes were fixed as marks in the ice, and the "interference area" studied where the upper ice of the Karajak streams meets the inland ice. In the winter months, Dr. Drygalski, with two trusty Greenlanders, explored the Great Karajak glacier. He took measurements on the relative rate of movement in the smoother and more cleft parts of the glacier. He tells how, as the big blocks of ice tumbled down, fine ice dust was raised, which hung like a transparent veil around the ice pillars and hummocks, sometimes catching the sun rays and glancing with color effects. Ice grottoes were found, the remnants of old water channels. In those the temperature was wonderfully high and the ice was quite moist.

From February until June, Dr. Drygalski and Dr. Vanhoffen were engaged in a long sleigh journey to the most northerly part of the Upernivik colony, in lat. N. 73°. At this latitude the outer margin of the great ice mantle of the interior extended to the sea level. Another tour which they attempted in June had to be given up on account of the warm Föhn wind. Before their final departure from Karajak, they ascended the ice once more to take observations on the bamboo marks previously set. Dr. Drygalski attributes the movement of the ice streams to their content of water, and says there would be no motion whatever unless the melting temperature were reached. Farther, the increase of temperature in summer, due to the downward passage of heated surface water, is much greater than the decrease of temperature in winter. The warming effect of the water is at its maximum in the deepest layers of ice, where also the movement is most marked. Microscopic examination of the ice also proved that it was thoroughly penetrated with water. It will be some time before the expedition can publish their results in detail. Dr. Vanhoffen's work was mainly biological.—*Nature.*

VENOMOUS AND POISONOUS FISHES.

FISHES, many of which are held in great esteem as an addition to our bill of fare, and which form a valuable food supply for the entire world, may, nevertheless, in some cases prove quite dangerous to man. Without speaking of the bite of fishes of large size, such as the sharks, whose formidable teeth are so much dreaded by bathers, we desire to dwell upon the casualties that may be occasioned by these animals through stinging or poisoning. In the case of a sting, the venom enters the wound made by the spines serving as organs of defense, and the poison acts in about the same way as that of snakes, scorpions and insects. When there is a poisoning, properly so called, the toxic principle is ingested when the fish is used as food and occasions a series of organic disturbances sometimes causing death.

Venomous Fishes.—Among the venomous fishes may be mentioned, as particularly dangerous, the common vive, or sea dragon, *Trachinus Draco*, as well as other species of the same genus, *T. vipera* and *T. aranea.* The first named species inhabits the English Channel, the Mediterranean Sea and the ocean. This is very likely the fish that Pliny (Hist Nat., xxxii., 53) calls the *draco*, and which he says stings like a scorpion when it is taken in the hand. Its first dorsal fin is provided with five hollow spiny rays filled with glandular cells that secrete a poison in the form of drops that escape to the exterior through the bursting of the cell. In addition, there is upon the upper part of the operculum a sting that points backward and that is grooved longitudinally and is surrounded by a membrane. In each of the grooves of this sting, and in a cavity at its base, there is a mass of glandular cells, which, when they become inflated with venom, burst and allow the liquid to reach the point of the spine. The contact of this liquid with the skin produces an excessive pain and a strong local tumefaction. Phlegmons and eschars often result, and sometimes even mortification and death supervene. At one time, police regulations required the fishermen to cut off the spines of the fish before offering it for sale. This rule is still in force on the coast of the Mediterranean, especially in the city of Cette.

The sting of the *Scorpæna antennata* and *S. grandicornis* is no less dangerous. These fish are called *rascasse vingt-quatre heures* in St. Domingo on account of the rapidity with which they cause death. Other venomous species of the genus are *S. porcus* and *S. scrofa*, sea scorpions; *S. diabolus*, sea devil; *S. bufo*, sea toad, of the Mediterranean, and *S. Mesogallica*, of the Antilles. The venom apparatus has its seat in the spiny rays of the dorsal fin. Each spine is surrounded by a sheath that secretes the poison.

It is also at the level of the dorsal fin that the venom apparatus of the *Pterois muricata*, of the Mascareigne Islands, is located. The rays of this fin are as brittle as glass and the pain caused by the sting is intolerable.

Nadeaud and Bottard have described in detail the venom apparatus of the species of *Synanceia*—*S. brachio*, *S. horrida*, *S. verrucosa*, etc., fishes found near the Seychelles, the island of Mauritius, Reunion, Java, Borneo, the Moluccas, Tahiti, and New Caledonia. The dorsal fin is provided with six soft and thirteen spiny rays, each of which contains a longitudinal channel communicating with a venom sack, which is oblong and terminates in a point at its upper, closed extremity. Each reservoir contains from eight to ten glands that secrete a clear, acid liquid. The reservoir is swollen with venom, and a simple pressure suffices to cause it to burst at its upper extremity. The venom then follows the channels of the spines and enters the wound made by the latter. Without such external pressure, the animal can do no injury. The fish buries itself in the sand or hides under rocks and assumes the color of its surroundings. This renders it difficult to be seen and explains the frequency of the accidents that it causes.

The sea scorpion, or bull head, *Cottus scorpius*, of the seas of the North of Europe, carries upon the operculum three channeled spines, each of which corresponds to a venom apparatus composed of glands that secrete a poison only at the moment of spawning and that remain atrophied in the intervals. It is therefore only at spawning time that the fish is dangerous.

In the order of Plagiostomi, the *Trygon pastinaca* and *T. violacea* present on each side of the tail one or more barbed stings, the wound from which is to be dreaded. The entrance of these spines into the tissues is followed by intense pain and violent convulsions, and a person wounded by them soon succumbs if relief is not afforded him.

The *Murœna helena*, sea eel, of the Mediterranean, a fish highly prized by the ancients, who fed it in ponds constructed expressly for it, and into which Vedius Pollio caused his trangressing slaves to be flung as food for the fish, has well developed teeth connected with a poison reservoir located in the palate and containing almost a cubic centimeter of liquid. Four strong conical teeth without channels, situated upon the median line and articulated with the palate bone, are capable of moving backward and bathing in the venom. When the animal brings these teeth to a vertical position again, the mucous membrane of the palate which sheathes them is stretched and compresses the poison reservoir. The venom then flows along the teeth to the wound. On each side of these four teeth there are three or four other movable ones that likewise communicate with the reservoir.

The *Plotosus lineatus*, *P. castaneus* and *P. limbatus*, which are found in the Indian Ocean and off the

coasts of Japan, Malabar and the Reunion Island, also are provided with a venom apparatus, which is situated in front of the pectoral and dorsal fins. It is a fibro-vascular sack, provided with muscles and communicating with a channel in the first spine of the dorsal fin. This canal ends at a short distance from the free extremity of the sting, and it is, therefore, only necessary for the foot of a bather or the hand of a fisherman to break off the extremity of the spine in order to allow of the immediate flow of the compressed venom into the wound, which often proves fatal. The animal is incapable of using this apparatus, which is purely defensive. The same is the case with the *Doras* of South America.

The *Amphacanthus luridus* and *A. Javanicus*, of the Indian Ocean, are provided with a venom reservoir in the membrane uniting the spiny rays of the anal and dorsal fins. As in the preceding cases, the liquid exudes from the extremity of a spine.

The *Thalassophryne reticulata*, of the Pacific Ocean, is provided with two dorsal spines, communicating at the base with a peculiar venom apparatus, that can be emptied only through compression. The operculum likewise is provided with a sting pointing backward and communicating with a venom reservoir embedded in the operculum.

We may mention also as possessing analogous venom apparatus: the *Niphon spinosus*, of Japan, the spines of the dorsal and anal fins of which, as well as those of the operculum, are dangerous; the *Serranus ereolus* and *S. arrara*, of the Antilles, belonging to the perch family; the *Lophius setigerus*, or bristly angler; the *Dactylopterus volitans*, or swallow fish; the species of *Apistus*; several species of *Acanthurus*, or surgeon fish, etc. Finally, the genera *Diodon* and *Tetrodon*, the individuals of which are called puffers, globe fish, or swell fish, likewise include species that inflict painful wounds.

Poisonous Fishes.—The poisonous fishes produce still more serious effects on those who use them as food; and it is not a rare thing for them to cause death.

The toxic properties of certain fish have been known from the remotest times. Hippocrates tells us that the Greeks anciently avoided eating fish because certain kinds were injurious to the organism. Alexander the Great forbade his soldiers to eat fish, because he was convinced that some species were capable of producing skin diseases. Galen asserts that when the conger eel, *Leptocephalus conger*, is used as food it causes a derangement of the digestive organs and a serious disturbance of the nervous system. It appears that in Japan, in the seventeenth century, there existed a law by virtue of which the children of the officers and soldiers who had died from the effects of eating a poisonous fish called *fugu* lost the right of succeeding to the profession of their father. At present, in the same country, the sale of poisonous fish in the markets is punished by a fine. In other countries, likewise, the governmental authorities have taken measures of protection, either by means of laws forbidding the sale of fish known to be poisonous, or in making known the dangerous fish to the ships arriving in the ports. Poisonous fishes are particularly numerous in certain regions such as Japan, New Caledonia, the Antilles, Brazil, and the Cape of Good Hope. We shall enumerate the principal toxic fishes in following the zoological order.

In the family of Gymnodentes, the moon-fish or short sun fish, *Orthagoriscus*, and various globe fishes, of the genera *Diodon* and *Tetrodon*, are certainly poisonous. The *Tetrodon sceleratus*, of the Cape, is so noxious that, in addition to warnings through placards, it has been deemed prudent to exhibit one of these fishes in a glass globe on the public square of Cape Town.

In the family of Clupeidæ must be mentioned a few species allied to the common herring, such as the sardine of the Antilles, *Clupea humeralis*, the *Meletta thrissa*, the groundling or melet, a sort of herring inhabiting the seas of the Antilles and China and the coast of Brizil, and the *M. venenosa*, a species widely distributed through the waters of New Caledonia and the neighboring islands. We know from a report made in 1856 that of fifty men of the crew of the Catinot who partook of the last-named fish as food at Balade, thirty exhibited more or less serious symptoms of poisoning, and five died.

The greatest number of poisonous fish belong to the order of Acanthopterygians, and it is these that it remains for us to mention. In the Percidæ or perch family, several species of *Serranus*, found near Martinique, Guadeloupe, and Havana, prove at times very noxious. The *Anthias jocu*, of the Antilles, called the dog-toothed sardan, is very poisonous. In the family of Sparidæ must be mentioned the pager, *Sparus pagrus*, the *Chrysophrys sarba*, called parrot and paved-mouth on the island of Mauritius, and found also at Pondicherry, Hindostan, and the *Lethrinus mambo*, of New Caledonia. The family of Triglidæ furnishes the *Scorpæna grandicornis*, the sea scorpion, known at Martinique by the name of sea toad, at Havana as rascasse, and at Saint Domingo as *rascasse vingt-quatre heures* (the twenty-four hour rascasse), on account of the rapidity with which it poisons. In the family of Scombridæ we have the common tunny, *Thynnus vulgaris*, which frequently proves poisonous at Martinique and Guadeloupe, the Spanish mackerel, *Scomber Dekayi*, which, although regarded as a delicacy by some, proves positively noxious to others, and a species of *Cavaux*, which is regarded as very poisonous in Havana.

Finally, of the family of Gobidæ, the *Gobius criniger*, the hairy goby or *Calououlouve* of Pondicherry, is regarded as noxious as food.

The toxic principle of fishes acts with great celerity and affects the nervous system as well as the glandular organs of the upper part of the digestive tube. According to the observations of Dr. Remy, the symptoms of poisoning begin with nervous disorders, headache and vomiting, and continue with convulsive phenomena, paralysis and a difficulty in breathing capable of causing death.

What is the real cause of these toxic properties of fishes? Many explanations have hitherto been given that do not appear to be based upon sufficiently accurate observations; but it seems at present pretty definitely settled that it is due to a certain state of the eggs at the time of spawning. This explanation agrees perfectly with various observations that have been made for a long time back. It has been remarked that the toxic properties of fishes do not manifest themselves at all times of the year, that they vary with the age of the animals, and that the adult ones alone are truly poisonous. Finally, while certain scientists, Linnæus among them, have supposed that the poison was localized in the head of the fish, and others have attributed poisonous properties to the flesh itself, more attentive observations have demonstrated that the toxic principle is localized in certain parts of the body, and especially in the digestive tube, the liver and the eggs.

Mr. De Rochas was one of the first to attribute the poisoning caused by fishes to the action of their spawn, and consquently to their age, and he ascertained the fact with regard to certain species of New Caledonia. Messrs. Fonssagrives and Leroy de Mericourt, in 1861, adopted the same theory, while at the same time hoping that still completer experiments might be made. The researches of Dr. Remy in Japan and those of Dr. Savtschenko ("Atlas of Poisonous Fishes," St. Petersburg, 1886), are thoroughly conclusive as regards the species of the genus *Tetrodon*, which caused in dogs the same symptoms of poisoning as those observed in man after they had been fed upon the eggs and genital organs of these fish. It appears, then, that the cause of poisoning by fishes resides in a peculiar state of the eggs at the period of fecundation and spawning. Finally, it is well to add, in terminating these considerations upon the toxic principles of fishes, that, according to a comparatively recent discovery, the blood of eels and of fishes belonging to the same family contains a venom comparable with that of the viper, and which, like the venom of snakes, may be swallowed with impunity, but which, introduced into the blood, is of such a nature as to cause death. The inoculation of various animals with the blood of the eel has quickly killed them.—*La Science Illustrée and Le Magasin Pittoresque.*

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

RESTORATION OF CAMPTOSAURUS.

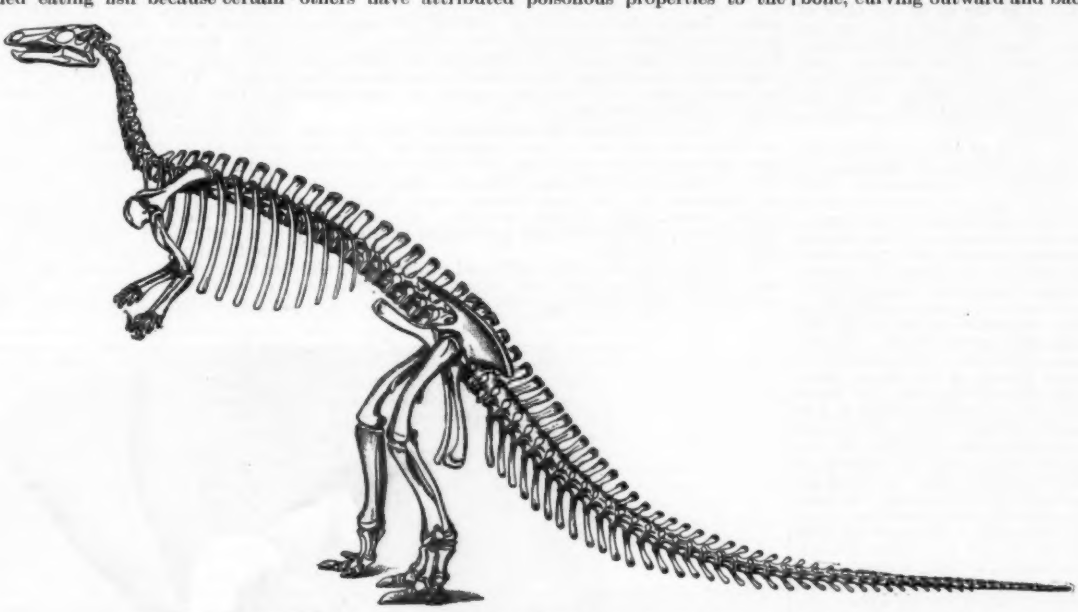
By O. C. MARSH.

THE Jurassic deposits of western North America contain the remains of many gigantic Dinosaurs, and various skeletons of these have been obtained by the writer, who has described the more important forms. Restorations of the skeletons of three of the most interesting genera, *Brontosaurus*, *Stegosaurus*, and *Ceratosaurus*, have already been given in this journal, and another of these huge reptiles is thus represented in the cut accompanying the present article. Each of the three forms previously restored was a typical member of a distinct group of the *Dinosauria*, and this is true, although in a less degree, of the present genus, *Camptosaurus*. Restorations of *Anchisaurus* from the Triassic, and *Claosaurus* and *Triceratops* from the Cretaceous, all Dinosaurs of much interest, have likewise been published by the writer in the present journal.*

The restoration here given is based upon the type specimen of *Camptosaurus dispar*, one of the most characteristic forms of the great group *Ornithopoda*, or bird-footed Dinosaurs. The reptile is represented one-thirtieth natural size. The position chosen was determined after a careful study not only of the type specimen, but of several others, in excellent preservation, belonging to the same species or to others nearly allied. It is therefore believed to be a position frequently assumed by the animal during life, and thus, in some measure, characteristic of the genus *Camptosaurus*. The present species, when alive, was about twenty feet in length, and ten feet high in the position here represented.

The genus *Camptosaurus* is a near ally of *Iguanodon* of Europe, and may be considered its American representative. *Camptosaurus*, however, is a more generalized type, as might be expected from its lower geological horizon. It resembles more nearly some of the Jurassic forms in England generally referred to *Iguanodon*, but, as these are known only from fragmentary specimens, their generic relations with *Camptosaurus* cannot now be determined with certainty.

In comparing *Camptosaurus*, as here restored, with a very perfect skeleton of *Iguanodon* from Belgium, as described and figured, various points of difference as well as of resemblance may be noticed. The skull of *Camptosaurus* had a sharp, pointed beak, evidently incased during life in a horny sheath. This was met below by a similar covering, which inclosed the predentary bone. The entire front of the upper and lower jaws were thus edentulous, as in *Iguanodon*, but of different shape. The teeth of the two genera are of similar form, and were implanted in like manner in the maxillary and dentary bones. In *Camptosaurus* there is over each orbit a single supra-orbital bone, curving outward and backward, with a free extremity, as in the existing Monitor; a feature not before observed in any other Dinosaur except *Laosaurus*, an allied genus, also from the Jurassic of America. Other portions of the skull of *Camptosaurus* as well as the hyoid bones appear to agree in general with those of *Iguanodon*.



RESTORATION OF CAMPTOSAURUS DISPAR, MARSH. (One-thirtieth natural size.)

The vertebræ of *Camptosaurus* are similar in many respects to those of *Iguanodon*, but differ in some important features. In the posterior dorsal region, the transverse processes support both the head and tubercle of the rib, the head resting on a step, as in existing crocodiles. The five sacral vertebræ, moreover, are not co-ossified, even in adult forms, and to this character the name *Camptonotus* first given to the genus by the writer in 1879 especially refers.† Another notable feature of the sacral vertebræ of the type specimen should be mentioned. The vertebræ of the sacrum, especially the posterior four, are joined to each other by a peculiar peg and notch articulation. The floor of the neural canal of each vetebra is extended forward into a pointed process (somewhat like an odontoid process), which fits into a corresponding cavity of the centrum in front. This arrangement, while permitting some motion between the individual vertebræ, helps to hold them in place, thus compensating in a measure for absence of ankylosis. A similar method of articulation is seen in the dermal scales of some ganoid fishes, but, so far as the writer is aware, nothing of the kind has been observed before in the union of vertebræ.

In *Camptosaurus*, the sternum was entirely unossified, and no trace of clavicles has been found. The pelvis of *Camptosaurus* differs especially from that of *Iguanodon* in the pubis, the postpubic branch being even longer than the ischium, while, in *Iguanodon*, this element is much shortened.

In the fore foot of *Camptosaurus* there were five functional digits, the first being flexible, and nearly parallel with the second, thus differing from the divergent, stiff thumb of *Iguanodon*. The hind feet had each three functional digits only, the first being rudimentary and the fifth entirely wanting, as shown in

* This journal, vol. xli., p. 339, April, 1891; vol. xlii., p. 179, August, 1891; vol. xliv., p. 343, October, 1892; and vol. xlv., p. 169, February, 1893.

† This name proved to be preoccupied, and *Camptosaurus* was substituted for it. This journal, vol. xxix., p. 169, February, 1885.

the cut. The entire skeleton of *Camptosaurus* was proportionately more slender and delicately formed than that of *Iguanodon*, although the habits and mode of life of these two herbivorous Dinosaurs were doubtless very similar.

The type specimen of *Camptosaurus dispar*, used as the basis of the present restoration, is from the Atlantosaurus beds of the upper Jurassic of Wyoming. This species and other allied forms will be described in full in an illustrated memoir now in preparation by the writer for the United States Geological Survey. The present restoration is reduced from a large drawing made for that volume.

New Haven, Conn., February 23, 1894.

THE VOLCANO CALBUCO, IN CHILE.

PISSIS, in his "Physical Geography of Chile," expresses himself as follows:

A very low gorge, nearly at the level of the plain, separates the rocky mass of Osomo from the volcano

FIG. 1.—CALBUCO AND ORNO, IN CHILE.

Calbuco, whence it extends as far as to the Gulf of Reloncavi. To the south of Jaimes (3,011 meters) are seen Villarica (2,837 meters), Quetrapillan (3,688 meters), the volcano of Cajara, Osomo (2,198 meters), and Calbuco (1,792 meters). These latter are situated entirely to the west of the Cordillera of the Andes and rise immediately above Lake Clanquihue, the altitude of which is about forty meters.

Calbuco is situated in 41° 20′ 5″ of south latitude and in 1° 59′ 8″ of longitude of the meridian of Santiago or 72° 38′ 35″ west of the meridian of Greenwich. Calbuco is a snow-covered, rocky mass, covered with thick forests. Its aboriginal name is Quillaipe or Quillepeu. Tradition preserves no remembrance of its having burned during the historic period, and yet those travelers who have traversed its base have all considered it as an extinct volcano, on account of its geological structure. The first to make the ascent of Calbuco was Mr. Charles Juliet, a naturalist attached to Mr. Vidar Gonnaz's hydrographic commission. He ascended it at the northeast side in the month of February, 1872. In the month of March of the same year, two intrepid excursionists, Messrs. Christee and Dawton, made the ascent of it and ascertained that it was a volcano. Mr. Dawton descended into the crater, but his temerity came near costing him his life. He lost his clothing and his instruments, and was unable to regain the summit until after forty-eight hours of indescribable efforts. The crater of Calbuco has the form of an irregular pentagon, slightly elongated from west-northwest to east-southeast, with a diameter of 2,000 meters. The altitude of the rim of the crater, according to a barometric observation, is 1,692 meters. The highest western edge was estimated at 46·3 meters, thus giving Calbuco a height of 1,738·3 meters above the level of the sea. The crater of Calbuco, when Mr. Dawton visited it, had at the bottom of its concavity a snow-covered hillock, exhibiting deep fissures that formed precipices. Gaseous emanations were proceeding therefrom.

Up to the present, Calbuco has been considered as an extinct volcano. Yet, since the beginning of last year (February, 1893), it has been awakening from its long state of lethargy and giving signs of activity. It began by projecting into the atmosphere columns of steam, followed by immense flames, accompanied with

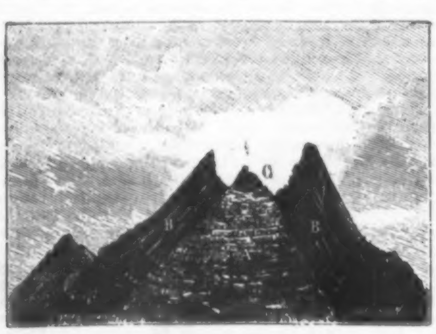


FIG. 2.—DETAILS OF THE CRATER OF CALBUCO.

A, andesites; B B, lava; C, red rocks.

subterranean noises and electric phenomena, and then an enormous outpour of volcanic sand and ashes. This eruption has not as yet (December, 1893), terminated. It is of a most remarkable character both by reason of its duration and its products. The following is the succession of the progresses of the eruption in 1893:

In February, clear, white vapors issued from the crater; in March, columns of smoke made their exit, and the snow melted on the mountain, which remained covered with a gray veil of fine ashes. The volcanic ashes and sand projected by the volcano kept increasing. The volcano threw out muddy water, which increased the torrents and covered the country traversed by them with mire. In April there were shakings of the ground, subterranean noises, and interior tempests. In May there were storms and electric phenomena; in June, earthquakes and subterranean noises; and in July, flashes of lightning, thunder, and storms unusual for the winter season. In August there was a relative calm. In September, there were five great eruptions, electric discharges, clouds of smoke and steam, and showers of volcanic ashes, that were carried to a distance of more than 120 meters. This month was marked by a great activity. In October, the quantity of ashes increased, and stones were projected from the volcano. On the 23d of this month there was a great eruption, strong commotions, detonations, a great abundance of ashes, and complete darkness during the day at Puerto Montt, Osomo, Anard, etc. On November 29 there was an extraordinary eruption, loud subterranean

FIG. 3.—MAP SHOWING THE POSITION OF THE VOLCANO CALBUCO.

noises, heavy detonations, a fall of an enormous quantity of ashes, and electric discharges, and the sun was obscured by a cloud of ashes. In December, the eruption continued, and there were noises, flames from the crater, and ashes. Craters opened at other points of the environs of Calbuco.

The theories regarding volcanoes are well known, but since the sand, ashes, and fragments of rocks confirm our views upon volcanism, we shall recall the fact that, in the opinion of some, volcanic ashes and sand are fragments of solid rock ground up in the interior of the crater, and, in that of others, the ashes are melted lava, subdivided and pulverized suddenly by great masses of steam.

In our opinion, the ashes and sand projected by Calbuco are derived neither from molten lava pulverized by steam nor from rocks ground up in the crater by indeterminate actions. The ashes and sand are derived from the explosion of the rock itself, which bursts and is reduced to fragments when it is heated to a certain temperature. The hydrated rock, holding a greater or less proportion of water, behaves like an explosive for the water and gases that it contains. A dynamo-chemical phenomenon occurs analogous to the explosion of a wet brick thrown into a blast furnace. Water or aqueous vapor coming into contact with molten lava is capable of dividing and granulating it; but then we find in volcanic ashes and sand these nitrified fragments.

Let us now take a look at the ashes of Calbuco. I have studied the ashes and sand of this volcano, as well as the fragments of stone projected, and have examined them with a polarizing microscope. The ashes and the unmolten intact rock have exhibited to me the same mineralogical and petrological characters.

The volcanic ashes are of a light gray color. They are composed of fragments of feldspar (triclinic) more or less divided, augite, hypersthene, or amphibole, magnetite, etc. The ashes have the same mineralogical composition as the andesites whence they are derived, and, moreover, the crystallized minerals have the same form in the ashes as in the rock. An observation of prime importance is that we do not find in the ashes and sand of Calbuco the vitrified granulations that have been noticed in certain volcanic ashes attributed to molten lava divided by steam and then projected into the atmosphere. A fragment of andesite thrown out by the volcano was submitted to a coarse artificial trituration and then the pulverized material was traversed by a current of steam. I thus obtained a sand analogous to the volcanic ashes collected at the time of the eruption of Calbuco.

The eruption of the volcano has caused atmospheric disturbances; the enormous quantity of steam that has been projected into the air and the electric phenomena have destroyed the equilibrium of the atmosphere; abundant rains have fallen in the central region of Chile and also in the north; the low mountains have been covered with snow; the sky has been covered with clouds; and the hygrometric state has varied. All these disturbances, accompanied at times with tempests, are due to the influence of Calbuco. The enormous quantity of water projected into the air by the volcano returns to the earth in the form of rain and snow. The eruption continuing, the period of equilibrium has not yet arrived.—*A. F. Nogues, in La Nature.*

RHODODENDRON MULTICOLOR MRS. HEAL.

THIS is a beautiful addition to the race of dwarf growing and free flowering rhododendrons which has been raised at Messrs. J. Veitch & Sons' nurseries, Chelsea. The numerous forms raised require a warm greenhouse temperature and a comparatively moist atmosphere for their successful cultivation. They have been obtained from R. multicolor and R. m. Curtisi, crossed with other species and varieties, and while larger flowers have been produced, the freedom with which the multicolors bloom has been in no way impaired. The latest variety, if we may so designate it, has been named in compliment to the wife of Mr. John Heal, the skillful hybridizer and manager of the new plant department at the Chelsea nursery. The flowers, as shown in the illustration, are of medium size, pure white and borne freely in umbels at the ends of every ripened growth. The habit is dwarf and free branching and the specimen exhibited at the Royal Horticultural Society on February 13, was a center of attraction and readily obtained a first-class certificate from the floral committee. R. multicolor Mrs. Heal is, without a doubt, the finest of its race, and will, when placed in commerce, become a popular warm greenhouse shrub suitable for decorative purposes in the conservatory, or for the supply of choice cut flowers.—*The Gardeners' Magazine.*

RHODODENDRON MULTICOLOR MRS. HEAL.

A STEEL METEORITE.

AMONG the many objects collected by the Peary expedition to Greenland, in 1891, was a meteorite weighing about 267 pounds. It was found by Prof. A. Heilprin, near Godhaven, Disco Island, and sent to the Academy of Natural Sciences, of Philadelphia, in the Proceedings of which (1893, p. 373) it is described by Mr. E. Goldsmith. When received at the academy, the meteorite appeared to be solid and devoid of cracks or any signs of disintegration, but this condition soon changed, and the mass slowly cracked and began to fall to pieces. It is thought that this crumbling was due to

oxidation, resulting from the existence of a higher temperature and a greater quantity of ozone in the latitude of Philadelphia than in that of Greenland. Mr. Goldsmith has examined some of the pieces separated from the mass.

The substance could easily be separated into hard, metallic, and tough granules, and a powder capable of reduction to any degree of fineness. A determination of the separated quantities gave 73·8 per cent. as the proportion of the granules and 26·2 per cent. as that of the powder. The specific gravity of the former proved to be 6·14 and of the latter 4·73. One of the pieces from the meteorite was reserved for grinding and etching, but it was found that the process involved considerable difficulty, owing to the extreme hardness of the specimen. Indeed, the mass was so hard that it would scratch soft iron, making an impression visible to the eye and sensible to the touch. This and other tests seem to warrant Mr. Goldsmith calling the object a tempered steel meteorite. Possibly the meteorite fell into a pool of water or deposit of snow or ice, and was thus quickly cooled down from the heated condition obtained by rushing through the atmosphere.

Analyses show that there is a distinct difference between the granules and the separated dark powder. The former contains a sulphuret, probably troilite; the latter contains no sulphuret, but, instead, a sulphate. Iron, nickel, sulphur, traces of carbon, chlorine, phosphorus, and chromium were found; also a silicate in which lime and magnesia were recognized. Copper and cobalt were searched for, but in vain. According to Prof. A. E. Nordenskiold and J. L. Smith, the Disco Island terrestrial iron contains copper, cobalt, phosphorus, and comparatively large quantities of carbon. As Mr. Goldsmith remarks, these differences are too great to be overlooked in comparing analytical work; they indicate that the mass found by Prof. Heilprin is not of terrestrial, but of celestial, origin.

SOME USES OF SNOWSHOES.

WHEN a colony settles in any region, the colonists' first idea is to open up communication with the outside world for commerce and friendly intercourse. So, from early ages, dwellers in the far north of Europe and Asia sought some means of passing through the deep snow covering the mountains and valleys around them for the greater part of the year. From this need sprung the idea of snowshoes, which, in an improved form, are to this day the chief means of locomotion in most high northern latitudes during the long winter.

Originally the shoe was broad, and made either of hide or of the pliable willow. As time went on the shoe developed into a long, narrow form, as less likely to make the wearer sink into the soft snow. Further, it was found that, as the greatest difficulty in using snowshoes lay in the moving forward, a long shoe glides more easily over lightly frozen snow, and is not so likely to slip back. Different nations soon adopted different shapes and sizes, but the main idea of the shoe was identical. At present the kind most used in Norway and Sweden, as well as in other countries, for racing purposes, is the so-called "Christiania snowshoe." This shoe is very long and narrow, its furrowed sole is slightly arched, and it bends upward sharply in front. With these no stick is needed either to aid the wearer's progress or to act as drag—a great advantage if the shoes are used for military purposes. The Finnish snowshoes are also employed in the Russian army. These are extremely long, and the sole is broader than that of the Christiania shoe. Both ends bend upward slightly. However, the Finnish shoes require some kind of support in the shape of a staff as drag. This necessity interferes with the free handling of arms, so the Russian military authorities prefer to use the Russian snowshoe. Though somewhat heavier, these latter shoes are shorter and broader, besides having raised rims to the upper surface of the shoe, which support the foot, and make it easier to maintain the equilibrium. Thus, during drill or maneuvers no staff need be used, leaving the soldiers' hands free.

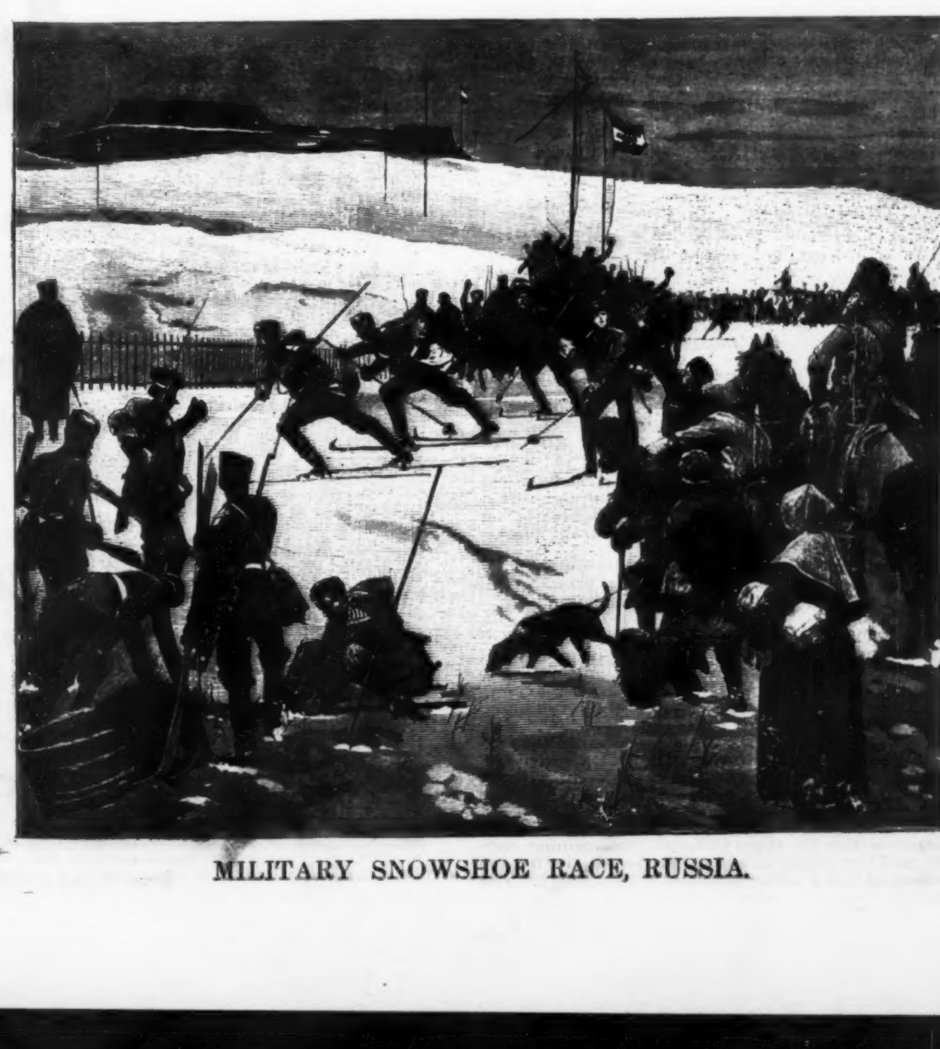
The use of snowshoes in warfare dates as far back as their employment for hunting or general traveling purposes. Their history can be distinctly traced from the twelfth century. Not only were they used then for racing and recreation, but they were largely adopted by scouts and messengers spying out the strength and position of an enemy. Later on, in the fifteenth and sixteenth centuries, regular snowshoe companies were formed for service in the Swedish and Norwegian wars. They were employed for any task which required great rapidity or power of movement. When a heavy snowfall prevented Charles XII.'s army from making a sudden swoop upon Norway, the Swedish king sent small detachments of snowshoers over the frontier to keep the Norwegians in a perpetual state of alarm. At the beginning of the present century Norway revived these snowshoe companies. The members were volunteers, selected from the best and most intelligent men in the army, and enjoyed certain advantages. Thus the snowshoers received higher pay than their comrades, besides being entitled to an immediate discharge at the close of the campaign. How their value was recognized may be seen from the fact that, in the middle of the present century, Norway possessed a special corps of six companies of snowshoers, mustering one hundred men to each company. Scandinavians are especially proficient because they are so accustomed to the national sport of "ski" races. To pass from the Old World to the New, the snowshoe has been familiar to the American Indians and the Canadians from the earliest period of their history. Nowadays the Canadians use the shoe for purposes of amusement only. Some of the chief features of the Quebec and Montreal carnivals are always the cunning feats and picturesque garb of the various corps of snowshoers, who go through the most elaborate evolutions.

From the days of antiquity Northern Europe has found the time for warlike operations very much limited by the difficulties of communication and the nature of the climate, with its brief fine season. Not so in Central Europe. There war is carried on under totally different conditions. An army is neither forced to go into long winter quarters nor to depend upon a good or a bad season. The generals reck nothing of wind or weather, ice or snow, but pursue a steady aim with untiring energy. The modern scheme of warfare is to break down resistance by striking swiftly and heavily; to overpower the enemy in the quickest time possible, leaving the vanquished no opportunity for rest nor for gathering together any considerable force against the invaders; to stop all trade and commerce, and to crush the national prosperity by draining the country of money and supplies for the maintenance of the attacking army within her borders. Such a campaign greatly depends for success upon the scouting, watchfulness, and rapid pursuit by the cavalry. The intelligence service between the cavalry and the main body of the army has to be kept up by the help of the field telegraph and telephone, but this is no light task,

MILITARY EXERCISES WITH SNOWSHOES.

as the lines encounter numerous obstacles in passing through an enemy's land or through difficult country, especially in winter time. It is here, therefore, that the use of the snowshoe is patent. The experience of the Franco-German armies during the winter campaign of 1870–71 effectually confirmed the opinion which experts had long expressed that calvary and wheeled vehicles would be practically useless in a severe cold-weather campaign. As that experience was obtained in the relatively mild climate of France, the case would be all the more marked on a more northerly battle ground and in a mountainous or less cultivated country. Swedish history relates that at the beginning of this century a whole regiment of dragoons were destroyed by a mere handful of armed snowshoers, simply because every attempt of the riders to get near their swift-footed opponents failed in the masses of deep snow. Accordingly it seems highly probable that snowshoes would have been of the greatest service to the German troops during the winter combats in northern France, on the Loire or in the Jura, and in frustrating the repeated attacks of the French *franc-tireurs* hanging on the skirts of the German army. On snowshoes a small detachment could have ignored the difficulties of the heavy snowfall and the icy roads which so impeded cavalry operations.

It is the duty of every military leader concerned with army organization and tactics to prepare in time of peace for warfare in every possible scene of conflict, in every climate, and at every time of year. Recognizing this fact, Russia has been studying the subject of snowshoe use for more than seven years past. There is no doubt that in a winter campaign she would have a great advantage over her western neighbor through the nature of her forces alone. Not only is the patient, unassuming Russian soldier hardened against climatic influences, but he is better equipped and prepared for such an important undertaking than any of the men in other armies. Accustomed to the bitter atmosphere of his native steppes, the Russian can make himself quite happy and comfortable under circumstances where central European troops would find the weather and temperature very hard to bear. Thus, the Russian military authorities attach great weight to the fact that in the event of crossing the frontier, as planned on the Russian side of the border, their troops would be in far the most favorable position respecting customs and climatic obstacles. In the various military provinces of the Russian empire



MILITARY SNOWSHOE RACE, RUSSIA.

snowshoe drill has been practiced regularly for years past by a large number of infantry regiments, particularly by the Jager detachments, which are composed of four picked men from each company of the regiment. The following regiments are among the most efficient in snowshoe exercise: the Wyborg infantry regiment, the 86th regiment in Wilmanstrand, the whole of the 40th division, and the Finnish sharpshooters' battalions.

In the winter of 1891 the Jager commander of the above division in the military province of Kazan and the governments of Saratov, Samara, and Penza, took his men out on snowshoes for several days' training. In spite of most unfavorable weather—storms, snowshowers, and 25 deg. of cold, the men accomplished 697 kilometers in ten days. Having learned their lesson so well, the soldiers profited when they were transferred, in 1892, to the western frontier, being stationed round Bobnusk, in the military district of Wilna. The bitter snowy winter of 1892-93 gave the troops ample opportunity for snowshoeing through the vast forests of Polesie, which teem with bears, wolves, wild boars, and elks. Moreover, they were taken out in large scouting parties for snowshoe exercise with good result. They could not, however, quite equal the daily record of speed in the previous year, as the tremendous snowfall almost concealed the features of the country round. Sham fights were organized under great difficulties, where the snowshoers came out triumphant. The ordinary troops could not march through the deep snow, as they sank deep down into the soft mass. But those equipped with snowshoes glided quickly and easily along at racing pace, could wheel about in every direction, and fire, kneeling or standing, at will. Even the arrival of the reserves to support the front line and the opening of fire proceeded with the utmost speed and regularity. A similar favorable result followed when the troops were divided to simulate attack and defense, and a regular fight ensued. In consequence of this success, the crack guard regiments in the Imperial camp at Krasnoe-Selo went through similar exercises.

Always on the alert to pick up hints for her own army, Germany soon imitated Russia, while Austria followed suit. Snowshoe maneuvers were introduced in East Prussia, the Harz, the Vosges, in Hungary, and notably at Liebenburgen, in Galicia. It was found that a fortnight's instruction sufficed to make steady, agile men proficient in the exercise, and able to cover a distance of 70 kilometers in a day. The German soldiers have taken very kindly to the practice, and attain great rapidity. As Emperor William keenly enjoys witnessing any novelty in military matters, snowshoe exercises will be included in the winter maneuvers now being planned to take place near Potsdam. The only difficulty is that the winter has been too mild to provide much snow.

If we turn to the question whether snowshoe battalions will be utilized to any extent in future wars, it is not difficult, from past experience, to determine that they will play an important part when a heavy snowfall limits or prevents cavalry operations. Strong detachments of snowshoers could be attached to the cavalry divisions to assist them as scouts and sentries in the advance guard of the army. They could form part of the patrols and intelligence department, and keep the main body at headquarters in touch with the various divisions scattered about. They would be able to watch over the safety of the roads and the railway lines, go in advance to requisition provisions, succor the wounded, and fetch doctors and ambulance bearers to the place where the injured men were lying. In these branches of service the snowshoes are not only valuable for their rapidity but for their noiselessness, the thick snow effectually muffling any sound of footsteps. As the great importance which Russian military circles attach to snowshoes in warfare has so influenced German and Austrian army authorities, it might be worth England's while to consider the possibility of their use for her troops stationed near the Pamirs, or likely to be sent there. There can be no doubt that should a struggle arise with the Czar's legions in that region the Russian troops would not fail to take advantage of this latest innovation in the art of war.—*The Graphic, London.*

HORSE TRAINING AND EQUITATION AT THE SAUMUR SCHOOL OF CAVALRY.

CAPTAIN PICARD, one of the most distinguished professors of the Saumur School of Cavalry, has conceived the idea of having recourse to photography for the studies of horse training and equitation. In collaboration with Dr. Bouchard, he has just published an "Album d'Hippiatrique et d'Equitation de l'Ecole de Cavalerie"—a work of many years' labor, containing no less than thirty plates of large size, reproducing, by the Berthaud photolithographic processes, the results obtained.

This work is of interest, both from the standpoint of hippiatrics and photography.

The study under consideration bears in the first place upon the definition of the different types of horses of the French cavalry, beginning with their stock—pure English blood and pure Arabian blood.

It is certain, says Captain Picard, that these types have now assumed such relations through the fusion of blood that it is often difficult to distinguish them, and this is one reason more for fixing the traits characteristic of their country of rearing.

We give herewith two specimens of the horses represented, in selecting the breeds that are abundant in our cavalry. Fig. 1 shows a Norman horse and Fig. 2 a Vendean one.

The principles of training a horse at the school of cavalry are shown by most successful instantaneous photographs. Of this, the reader may judge from the specimens that we place before his eyes. Fig. 3 shows an exercise in the training of a horse—that of jumping a ditch, begun with the strap. Fig. 4, on the contrary, represents an exercise in the training of a cavalryman. It is the horse trained for the riding school and placed between the pillars. The cavalryman, without stirrups or reins, has to resist all the motions of the horse caused by the riding master.

Photography, so happily put to profit by the authors for representing the types of horses, the training exercises, and the studies of equitation, serves also for the teaching of many other branches of hippology. The defects of horses have hitherto been defined by anatomical drawings, which are assuredly very demonstrative, but it has appeared more practical to Captain Picard and Doctor Bouchard to represent their real aspect upon the horse through photography. The plates of the blemishes or defects are very curious. The same is the case with those relating to the school of farriery, in which are seen represented all the kinds of shoes, with the hoofs to which they are adapted.

The album terminates with a series of reproductions

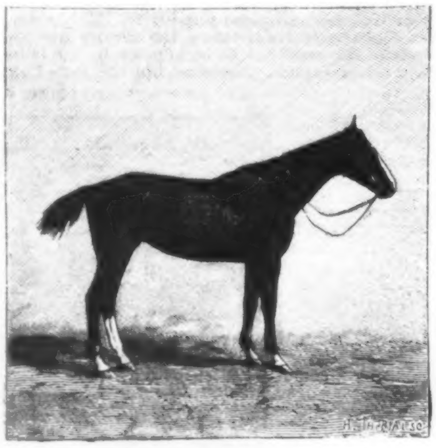


FIG. 1.—NORMAN HORSE.

FIG. 2.—VENDEAN HORSE.

FIG. 3.—TRAINING A HORSE TO LEAP A DITCH.

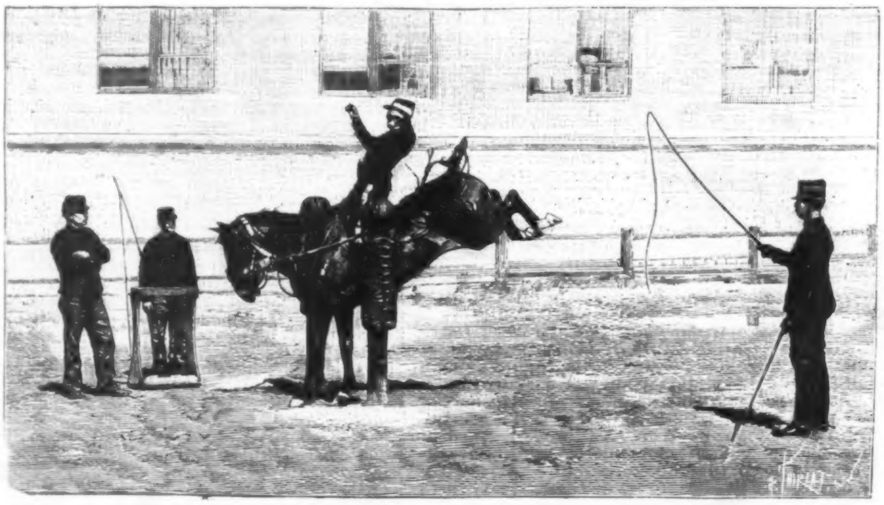
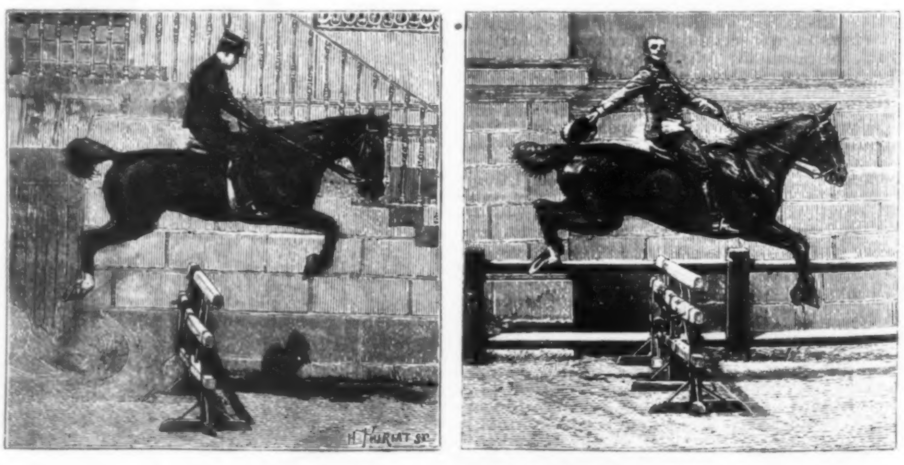


FIG. 4.—EXERCISE IN RIDING A HORSE PLACED IN THE PILLARS.



FIGS 5 AND 6.—JUMPING A BARRIER.

of photographs relating to the mechanism of the jump, demonstrated by a large number of horses at liberty, taken in all the successive phases of the jump. The different manners of a cavalryman's seating himself for a jump so as to avoid reactions are likewise represented from life. We have selected from the album two examples of jumping to a great height, and the horsemen in which have excellent attitudes (Figs. 5 and 6).

All these very instructive instantaneous photographs give a demonstration of the attitudes and gaits that competent men would consider as absolutely improbable.

Is it not surprising, says Captain Picard, to see, for example, photographs of horses on a racing gallop in which the animal rests upon a single foreleg, when all horsemen agree in making of the racing gallop a two-time mechanism, and horsemen reputed immovable in the saddle who are shown by the photograph displaced in the jump like young recruits.

With practice, the eye is quite capable of finding in nature what the photograph has revealed. Such education is quickly attained.

What has not one said to us, continues Captain Picard, on seeing for the first time a horse photographed in the act of jumping and represented as landing upon a single forefoot? How could this organ withstand the impact? Would it not be broken? And yet what is certainly more logical, it must be admitted that the horse divides the shock between his four limbs in placing them successively and in utilizing the pasterns as a spring.

Upon the whole, the authors of the fine work that we have just made known do not fear to assert that they have found in photography the most valuable aid for the study of hippiatrics and equitation.—*La Nature.*

TRACTION OF BICYCLES BY DOGS.

THE bicycle, by reason of the services that it is rendering, is on the road to conquering the world. In some cities, such as Cosne, all the physicians, and in others, such as Tulle, all the sheriff's officers, go about on bicycles, and the number of road trustees and letter and newspaper carriers that employ this mode of conveyance is daily increasing. This method of traveling is at once economical, rapid, convenient, healthful and agreeable.

The progress made in cycling is due to three great improvements, which have not as yet been applied to carriages and railway cars. The first is the use of balls placed between the axle and the wheel, so as to diminish friction, and the second and third are due to pneumatic tires. It is demonstrated, in fact, by mechanics, that the ideal wheel would be the one in which the spokes were perfect spiral springs. Now, the rubber tube approaches such ideal. Moreover, when a pneumatic tire comes into contact with a stone, it does not, as in an ordinary vehicle, oblige the entire load to pass over the obstacle, but allows the latter to penetrate it, so that, despite the numerous inequalities of the road, the bicycle rolls (theoretically at least) as if upon a smooth roadway. Therefore, it suffices to adapt a light motor to the bicycle in order to make long runs without any trouble—a fact worthy of consideration in mountainous countries, especially by those whose travel from one place to another should not be counted as a fatigue and be added to the day's work.

TRACTION OF A BICYCLE BY A DOG.

In this sense, it seems to me that the use of dogs ought to render signal services. I am able to mention, as an example, the results that I have obtained this summer at Mont-Dore and Bourbole, whither I go every day. These two thermal stations are four and a quarter miles apart, with a difference of 650 feet altitude and very steep gradients. With my bicycle, I make much better time than carriages in the descent from Mont-Dore to Bourbole, but, in order to ascend the four and a quarter miles that separate the two stations, it is necessary, in hot weather, to have at one's disposal a certain length of time for resting upon his arrival, which is something hardly possible for me. The following, therefore, is the idea that occurred to me. One of my patients owns a dog with which he easily makes from 30 to 35 miles a day. I requested him to train for me two animals for drawing a small dog cart, just as a horse would draw a small wagon. I must confess that at this time, at which I did not, as yet, know how to ride a bicycle, I had no very great confidence in the possibility of remaining upon the machine while a dog was drawing it. I consoled myself in advance in confining myself to making him draw my vehicle while I myself walked, that is to say, on steep acclivities. But what was not my astonishment and pleasure in finding my faithful Cæsar, from the first days of the experiment, saving me from all fatigue and especially drawing me rapidly. After a few days, I started in the presence of a fine assemblage of spectators, and, with my dogs on a gallop, went from Bourbole to Mont-Dore. Without a kick of the pedal, I was enabled to gain twenty minutes over ordinary carriages. Thanks to my invention, I have, therefore, been able to utilize the moments that every one takes for resting after each meal, while at the same time having myself carried rapidly and agreeably, and gaining, in going and returning, thirty minutes over carriages, and taking at will a more or less moderate exercise. I have thus effected a saving in a horse and especially in time, which is something not to be despised by one whose principal capital the latter is. I may add that every cyclist passed on the road received the offer of a re-enforcement, and more than twenty assured me that the traction of bicycles by dogs was the most agreeable thing in the world. I may add, too, that it is easier to sit upon a bicycle while a dog is drawing it than it is when one is proceeding alone. In long races, moreover, trainers do not hesitate to draw their racers, who then no longer have to occupy themselves with either the pedals or equilibrium.

Dogs have a considerable force of resistance. One day I made 20 miles of ascent on a gallop with a few minutes' rest at every 3 or 4 miles and in scarcely pedaling. Those who make use of dogs easily get from 35 to 60 miles out of them with a very poor vehicle. I know one who makes 90 miles with four dogs. It is true that in descents three dogs stand in the vehicle, that on level surfaces two only are harnessed, and that in steep acclivities the entire pack pushes or draws the wagon.

I know an amateur who has trained a dog to push along his bicycle at the side, and who, in return, generally offers him a seat on level surfaces and during descents.

If, as I hope, thanks to the aid of all those who are going to utilize my process, an arrangement be found that shall permit of ascending rapidly and of easily carrying the dog during a descent, distances of 60 miles will be made very quickly and especially without fatigue.—*Dr. Madeuf, in La Nature.*

A SPANISH RAILWAY ACCIDENT.

THE railway accident near Pajares on the Cantabrian Mountains, in Spain, writes a correspondent of the London *Daily Graphic*, was of a rather peculiar character and shows the dangers to which mountain railways are continually exposed. The accident occurred on the afternoon of Sunday, February 18, about one and a half kilometers from Pajares, at an elevation of about 2,000 meters and during a storm of snow. The train had received a second locomotive at Busdongo, and, having climbed the steep ascent and tunnel between that place and Pajares, had commenced the descent toward the Asturias, and had run past one of the most dangerous points upon the line, where a precipice on the one side is overhung by treacherous rocks above. Entering tunnel No. 45 at a speed of about twenty miles an hour, the locomotives slightly increased their speed, when, at the mouth of the tunnel, where a space of only 30 meters divides it from No. 46 tunnel, a mass of rocks fell immediately in front of and upon the leading locomotive, the driver of which had only time to lay his hand upon the whistle before the machine ran upon the obstruction. The second locomotive, with the accumulated force of the train of eight coaches behind, drove the first engine clear over the mass, both being utterly wrecked as to their running gear underneath. The laminated springs carrying the axle-boxes were thrown high on the rocks on each side, and locomotive number two finished its career by sliding on one crank up a mass of rock of about two yards surface measurement. The goods "fourgon," which followed the second tender, was uninjured even as to its buffer boxes, but the succeeding third-class carriage was partly telescoped by the next, which was forced forward by a first-class coach, the body of which left its running frame entire and forced its way onto those in advance. The succeeding carriage, in the first compartment of which I found myself, was quite uninjured. The buffer boxes, which were of cast iron, were all broken off downward and trailed on the ground between the wheels. The driver and stoker of the first engine were uninjured, but the second engine driver was badly cut about the head, and seven other passengers were cut and otherwise injured. After three hours in the tunnel we were thankful for the relief locomotive, although it only hauled us out into a misery of cold fog and snow. A risky tramp round the mountain side in twelve inches of snow at dead of night finally brought us to the train sent up to bring us back to civilization.

It may give a false impression to those who know little of the Asturian province unless I add that this line, with all its dangers, is a marvelous piece of engineering, second only to the St. Gothard, and running through magnificent scenery amid mountains rich in minerals from coal to gold, and where, in parts apparently quite neglected by the European sportsman, the chamois and the bear thrive.

THE DECAPITATION—A TRICK IN PRESTIDIGITATION.

THE stage represents a catafalque hung with black velvet ornamented with silver. In the center there is a large table with a cover that descends within a few inches of the floor.

The prestidigitator presents the subject whom he is to decapitate, lays him upon the table, and, taking a saber, cuts off his head and deposits it upon a plate lying near the feet of the subject at the end of the table. Then the spectators are invited to pass in procession upon the stage and to touch the head in order to assure themselves that it is still living.

FIG. 1.—THE CATAFALQUE.

Explanation.—The table upon which the subject lies is provided with a double bottom that rests upon pegs fixed in the four legs. In this double bottom is concealed a confederate, the make-up of whose head is such as to resemble that of the person to be decapitated. A resemblance is obtained by providing the two persons with similar false beads and eyebrows. The table is provided with a trap into which the subject lowers his head. The door of the trap turns and a false head places itself against the shoulders. The operator conceals this substitution by placing himself between the spectators and the subject. Then he takes a saber, passes it between the shoulders and the false head (a part of which representing the divided neck remains near the shoulders), and seizes the head by the hair in order to carry it to the plate. In carrying it he presses a button that has the effect of opening a tube whence a red liquid resembling blood escapes.

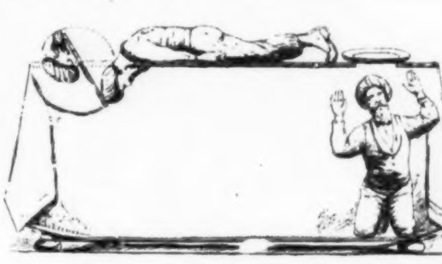


FIG. 2.—THE DOUBLE BOTTOMED TABLE.

In depositing the head upon the plate the prestidigitator hides it from view.

The confederate in the table opens a trap formed in the bottom of the plate, removes the false head and causes his own to appear in place of it.

The spectators defile along the railing and may touch the head in order to assure themselves that it is living, but the arrangement of the railing does not permit them to touch the body.—*Le Magasin Pittoresque.*

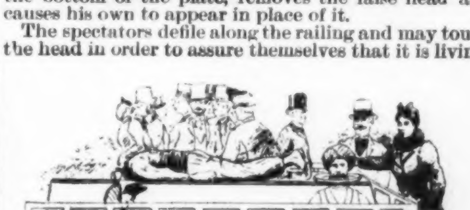


FIG. 3.—AFTER THE DECAPITATION.

A EUROPEAN authority on cholera believes that cholera can be exterminated by going to the root of the evil. This dis ase is endemic at the delta of the Ganges River in India, in a low area of about 7,500 square miles, caused by the putrefying remains of animal and vegetable life cast into the river by the inhabitants and constantly floating about. Formerly the fellaheen of Egypt interred their dead on the borders of the river Nile, and the bodies were then washed out into the stream during the annual overflow of the river, and were carried down to spread disease throughout the delta. Since an end has been put to this custom, the plague no longer harasses the country.

WATER TUBE MARINE BOILERS.

WE illustrate an improved type of water tube boiler, designed and patented by Messrs. Fleming & Ferguson, engineers and boiler makers, Paisley. We are indebted to the *Engineer*, London, for our illustrations, and the following particulars. This boiler is designed with the intention of taking the place of the ordinary cylindrical fire tube boiler—not merely with the intention of making the lightest boiler possible, or one with the greatest amounting of heating surface, which is too often gained at the sacrifice of working efficiency—but a boiler that will be capable of standing the everyday wear and tear of constant service on the longest voyages. The advantages claimed for this boiler over the present multitubular boilers are, a large decrease of weight for same power and pressure; lessening of the space required in the vessel; capability of carrying the highest pressures without the necessity of using abnormally thick plates; adaptability for quick steam raising without danger of straining the boiler; large, roomy furnaces; facility of examination for cleaning and repairs; no difficulty with tube ends or other parts when using forced draught; no stays of any kind required or used, and the trouble which these give by corrosion and leakage obviated; no joints or doors in connection with tube ends.

This boiler is suited for use afloat or ashore, and requires no more attention or care than the present ordinary type of boilers. It is suitable for all kinds of steamers, and can be worked, cleaned, and repaired by the ordinary class of men employed for such work. The upper drum or steam chest is of capacity which permits of the boiler being wrought without priming, fluctuation of water level, or variation of steam pressure. The tubes are curved, allowing free expansion without straining, at same time preventing scale gathering in the tubes, and they are placed zigzag, so that the flame has to wind through them. All the tubes are expanded at the ends in both drums. The lower drums are of sufficient diameter, and have manholes in the ends to permit of a man going inside and doing this work. By carrying a spare set of the longest tubes, any one of these may be cut, if required, to a length to replace any of the shorter tubes. A very important point in the design is the fact that any tube, whether in the center of the nest of tubes or elsewhere, can be taken out by drawing it into the upper steam chest, and a fresh tube put in its place without interfering with any other tube or taking down any of the casing or fittings. The outside diameter of the tubes varies from 1¼ inches to 2¼ inches, according to the size of the boiler. Greater heating surface might be got by using smaller tubes, but this would be at the expense of accessibility and facility for repairs and cleaning.

The furnaces and groups of tubes in large boilers can be divided into several divisions in each boiler. Boilers may be double ended and fired from both ends, as in the usual marine boiler, or they may be fired from the sides under the lower drums; the number of firing doors being arranged to suit length of boiler, giving a very large steaming capacity in one boiler. These boilers are well adapted for exportation, the drums being shipped separately, and tubes put in on arrival at destination and when in position, and the furnaces being so roomy are specially suited for burning wood or other refuse where coal is expensive. The design shown, which is No. 8, shows a boiler constructed for a working pressure of 300 pounds to Board of Trade and Lloyd's rules. This boiler was tested by water to a pressure of 650 pounds, and has been in constant use during the past year supplying steam to a set of quadruple engines driving the machinery of a large engineering and boiler works. This boiler has not given the slightest trouble in any shape or form, and although steam has been repeatedly got up in it within an hour from dead cold water, no signs of leakage have appeared anywhere.

The feed passes through coils in the smoke box, and is heated to about 100° before entering the end of the upper drum. The mud drums shown were fitted on account of the water being drawn from a rather muddy river, but in practice it was found they could have been dispensed with. In cases where deposit is likely to occur, the circulating pipes at the end of the boiler are carried down to a cross drum in which the deposit lodges, and is blown out as it gathers; the pure water only entering the lower drums from the branch above the deposit drum. This boiler since being put to work has been under inspection of the Board of Trade, Lloyd's, and British Corporation Surveyors, who all have expressed satisfaction. We are informed that on an evaporative trial with ordinary Scotch coal, it was found that when the boiler evaporated 4,400 pounds of water per hour the coal consumption was 480 pounds, the air pressure in the ashpit being 0·3 inch and temperature in funnel 480°, and when the full firing trial was made this boiler evaporated 5,500 pounds of water per hour. The casings round the boiler during the trials, which are double plated with asbestos between, were much cooler than an ordinary smoke box. Messrs. Fleming & Ferguson have in hand a set of these boilers for a steamer they are building for the Canadian government. Each boiler is to be capable of giving 1,000 horse power, and is being built to Lloyd's rules and under their survey. The working pressure is to be 220 pounds, and they are to drive a set of the builders' quadruple engines.

The following are the particulars of the various designs. All are for 200 pounds working pressure, except where otherwise stated:

No. 1.—Navy type, 1 furnace—
Heating surface .... 1,150 sq. ft.
Grate area .... 30 sq. ft.
Total weight of boiler and water, with casing and fittings .... 21 tons

No. 2.—Two separate boilers in one casing for steamer where it is desirable to keep height and width at a minimum—
Heating surface in both these boilers. 1,450 sq. ft.
Grate area .... 44 sq. ft.
Total weight of boilers as above .... 34 tons

No. 3.—Single ended two furnace boiler—
Heating surface .... 1,150 sq. ft.
Grate area .... 48 sq. ft.
Total weight, as above .... 23 tons

No. 4.—Double ended four furnace boiler—
Heating surface .... 2,200 sq. ft.
Grate area .... 88 sq. ft.
Total weight, as above .... 38 tons

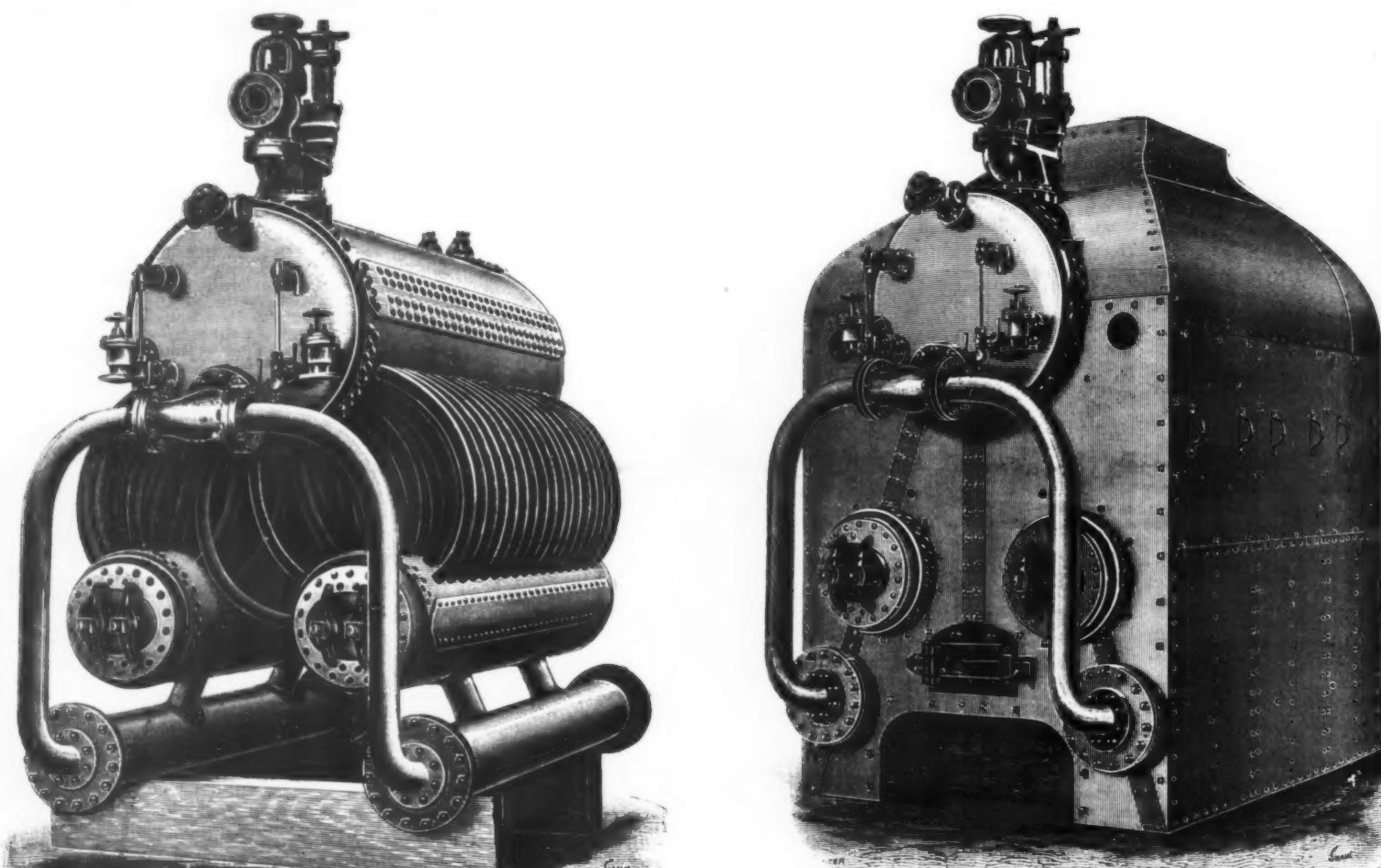
No. 5.—Single ended three furnace boiler—
Heating surface .... 1,550 sq. ft.
Grate area .... 60 sq. ft.
Total weight, as above .... 31 tons

No. 6.—Double ended six furnace boiler—
Heating surface .... 3,400 sq. ft.
Grate area .... 110 sq. ft.
Total weight, as above .... 55 tons

No. 7.—Double ended six furnace boiler—
Heating surface .... 4,800 sq. ft.
Grate area .... 138 sq. ft.
Total weight, as above .... 75 tons

No. 8.—Single ended one furnace boiler, particulars of which are given in our description—
Working pressure .... 300 pounds
Total weight, as above .... 13 tons 4 cwt.

No. 9.—Single ended one furnace boiler, divided into three divisions and having three furnace doors—
Working pressure .... 220 pounds
Heating surface .... 1,450 sq. ft.
Grate area .... 50 sq. ft.
Total weight, as above .... 30 tons



IMPROVED WATER TUBE BOILER.

HINTS ON DESIGNING TEXTILE FABRICS.

CHANGES often occur which have the effect of inducing producers of fabrics to enter into styles of manufacture new to them, in order to keep trade together. Thus an employer who, for a generation, has been engaged entirely in the production of gentlemen's cloths may suddenly desire to cater for the ladies or for other branches, where ornamental patterns are required. The designer finds himself nonplussed, because, being wanting in the knowledge required for constructing an ornamental pattern, he may also be entirely deficient in the first requirement, namely, drawing. This seems somewhat incredible, but we have personally met with designers who were unable to draw a simple scroll or flower. In such a case, what results? The manufacturer must either procure outside aid or look out for another man whose abilities lie in the direction specified. It is therefore necessary that every designer, no matter in what particular line he may be, should be proficient in the first of all requirements, viz., drawing. When this has been attained, practice in the technical details of ornamental pattern construction is required, and much may be done in one's spare time.

Professors at technical schools will bear out our statement that the student who comes out at the head of his fellows at the end of each session is the one who has given attention to ornamental designing, provided, of course, that his other knowledge is up to the requisite standard. We remember the case of a student who, each session, met with much success, and we who had opportunities of seeing his works had no hesitation in saying this success was well deserved.

It has occurred to us that something might be done in these pages to aid students and a certain section of designers in search of knowledge in mastering a few details of ornamental designing, while there are numbers of our readers connected with the textile trades whose business routine may lie in another direction, but who may still find our efforts of interest and benefit to them.

Suggestions for Designs.—There are many experienced designers who possess abundant stores of material—illustrated art works, scraps of fabrics, wall papers, Christmas cards, and such like helps of artistic merit—which have been gathered together at various times. These are intended to assist the imagination, the fertility of which is often a matter of surprise to

the outsider. There is no doubt such things are a great help to some designers. There are others who look to nature for much of their "material" in forming patterns, whose spare time is spent in the fields, the woods, or in gardens—studying trees, flowers, foliage, birds, insect life, light and shade, etc., etc., and who seldom or never depend on artificial aids in their work. Then, again, others utilize art and nature—sometimes one, sometimes another, and sometimes a combination of the two aids. There are others who refer to nothing visible, but will commence with a blank sheet of paper before them and, with great rapidity, will sketch object after object, until a complete design is the result.

This ability and power of imagination, however, are not attained readily, but are the result of much

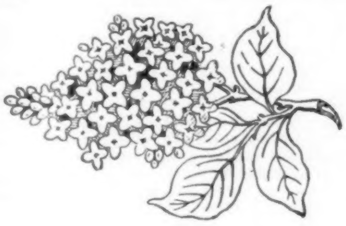


FIG. 1.

study, practice, and natural aptitude. The "easy way" for a beginner is to look about and notice what objects surround him from which he may take a suggestion upon which to build up his design. It is remarkable how easily such suggestions occur to one. Anything of an ornamental nature, however simple, is of sufficient importance to be noticeable. As an instance, we take one's home. There are curtains, carpets, table covers, wall papers, the picture frames upon the walls, the plants or flowers in the garden, the carving upon the furniture. These are all suggestive, and from a scrap of any of them the student may find a "motif," and, when once his pattern is in progress, he will probably be surprised to see how little resemblance it possesses to that which gave him his idea.

FIG. 2

There are no end of everyday objects which will strike the observant mind as of use. The windows of shops are a fruitful source of suggestion to some designers, while a mind ever on the alert will find, even in the streets, that ideas strike him as he walks along. A lady's dress or mantle, the ornamental carving upon a building, and the thousand and one things which one meets with are all sources of inspiration.

Correct Styles of Ornament.—A designer will usually possess one or two good illustrated books of designs, which will serve to educate him in the various periods or styles of ornament, as also in the correct effects of color incidental to the respective periods or styles. In these works, the primitive, the Persian, the Indian, the Egyptian, and the various other styles are profusely illustrated, and although in most branches of what we may term "commercial" designing not much attention is paid to "correct style" or "period," it is necessary for a student to be well up in such matters, as

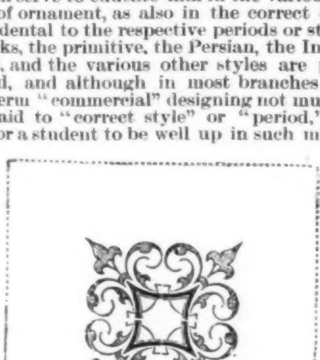


FIG. 3.

they tend to educate and enlarge the mind and ideas occur more freely, and finally he does not know how soon a call may be made upon him for any distinct style. There are many works published, the one known as "L'Ornament Polychrome" being among the most useful. This work contains an immense number of beautifully colored designs, which will be found an education to students.

We have spoken upon the ease with which a designer may receive suggestions, and it may be interesting and instructive to give an illustration of the manner in which a simple suggestion may be carried to a complete design. Fig. 1 shows a simple spray of lilac, which we may have noticed upon a Christmas card, or as an illustration in a book, or in its natural form in the garden. To construct a design from this is an easy matter to the experienced hand, but to a young

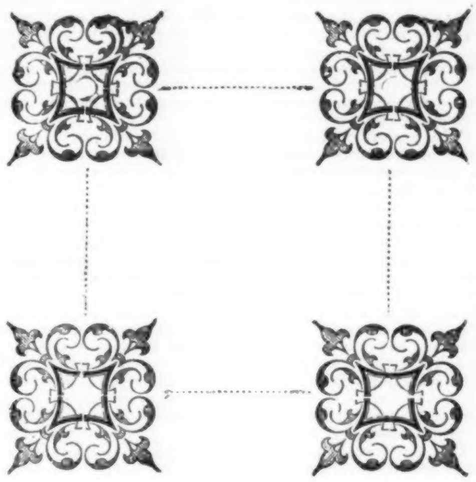


FIG. 4.

student, it is not so easy. In Fig. 2 we give the design constructed from the lilac. Of course, it is not necessary to hold fast to one particular flower. It is only the "motif"—other flowers may be introduced as desired to relieve what might otherwise be a monotonous pattern. The example is given simply to illustrate how a design may be drawn from any given object. Having dealt with the suggestive aspect of designing, we will pass on to the practical construction of

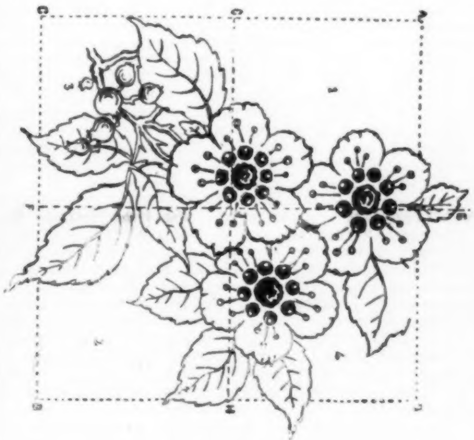


FIG. 5.

patterns, giving a few particulars and illustrations of the readiest methods of sketching designs.

An Elementary Design.—In the designing of a pattern, the first point to be taken into account is the size it must assume when woven. The design must be drawn to that particular size. Before proceeding further, we may say that those which repeat across or straight over form the simplest style of designing, and we, therefore, give samples of such. We will take, in the first place, an elementary pattern and will suppose

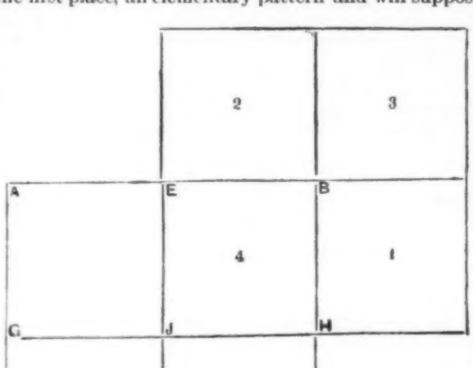


FIG. 6

the width of the woven repeat to be two inches and the length of the repeat the same. The boundary lines must, of course, first be drawn in pencil. These are represented by dotted lines, which form a square. In the center of these construct the pattern, as shown in Fig. 3. This will repeat upward and onward, at intervals of two inches, and the same will be the result wherever the position of the figure is within the boundary lines. Another method is given in Fig. 4, which will show clearly the repetition of the pattern. In this case the ornament is drawn in one corner and repeated at the other three. It is not necessary to make any further remark, beyond stating the fact that, on the ruled or point paper, a different quarter only of the ornament must appear, which will be found to join and repeat accurately when woven.

A More Elaborate Example.—Having given an elementary example, we will now come to one of a more

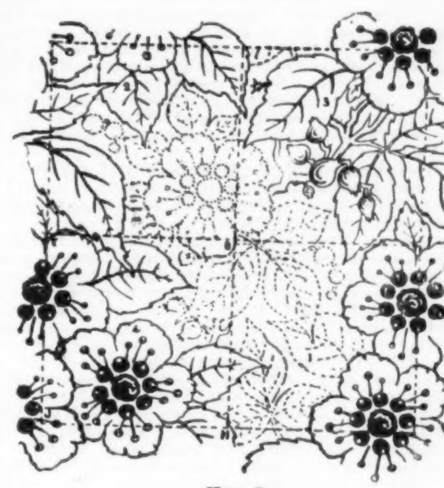


FIG. 7.

difficult character, and here again we will take a small repeat, simply as an illustration, as the actual size of a pattern of this character would be much larger, in order to look effective even in fine counts of yarn. The size of a repeat depends upon the requirements of the fabric for which it is intended and, of course, varies for different classes of cloths. We only mention this in passing. The method is the same, no matter what the size of the design may be. The boundary lines having been indicated, commence drawing the chief object—

FIG. 8.

a flower or figure—as shown in Fig. 5. And here it is necessary to remember that the pattern must be repeated, and that as much as possible without producing a liney or stripey effect, consequent upon certain patches of the groundwork or prominent portions of the figure successively catching the eye in an upward, onward, or diagonal direction. This is an error easily made, and should, therefore, be strictly guarded against. Having drawn a certain part of the pattern, the next step is to place it in its proper position, in order to secure the repeat, and this, in the case of a straight over design, requires that the ornamentation shall join at each side and at the top and bottom of the boundary lines. To accomplish this, the part already drawn must be traced. Lines E, F and G, H must be drawn. They will serve as dividing lines, showing the parts to be transferred to their respective positions, in order that the design may be completed.

An experienced designer will do this with the least possible amount of trouble, as experience suggests, but, for the novice, it will be the easiest way to construct a square of the same dimensions as A, B, C, D, in Fig. 5, a right angle of which is already shown at E, J, H, in the same figure. Having done this, continue the lines E, B and H, B as shown in Fig. 6. The portion of the pattern within the square 4 (Fig. 5) will not require transferring, but those parts within the squares 1, 2, and 3 must be transferred to the squares marked 1, 2, and 3 in Fig. 6. By referring to Fig. 7, it will be easily seen how this may be done and with what result. It will be noticed that an irregular space remains which requires filling. The continuation of the pattern has been made as indicated by the dotted lines in Fig. 7. Now trace the remainder in the squares 2, 3, 1, and transfer to their proper positions at 1, 2, 3 (Fig. 5), and a complete design will result, as shown in Fig. 8. It may be asked why not complete the pattern as shown in Fig. 7? This may, of course, be done, if preferred, but in Fig. 8 the main feature is clearly shown, while in the preceding figure it is divided. As a working pattern, sufficient is shown, but the designer may complete a square of Fig. 6, filling in his pattern, when, from the larger area covered, a better idea of its effect may be obtained.

THE New York obelisk was brought to this country in a specially prepared vessel, the hold being opened at the bow to admit the stone.

THE PASTEURIZING OF SILKWORMS.

By Leonard Wray, Jr., F.Z.S., Curator Perak Government Museum and State Geologist.

It is well known to all who take an interest in silk culture that this important industry, which is carried on extensively in Southern Europe, was, some years back, nearly ruined by the spread of the disease called pebrine. This disease is due to the presence of a bacterium, which is thus described by Mr. E. M. Crookshank in his "Practical Bacteriology": "*Panhistophyon ovatum*, Lebert. (*Nosema bombycis, micrococcus ovatus, corpuscles du ver à soie.*) Shining oval cocci, 2 to 3 μ long, 2 μ wide, singly and in pairs, or masses, or rods, 2·5 μ thick, and twice as long. They multiply by subdivision. They were experimentally proved to be the cause of *pebrine, gattine, maladie des corpuscles*, or *flecksucht*, and were discovered in the organs of diseased silkworms, as well as in the pupæ, moths, and eggs."

The last word of this description indicates how it is that this disease is so destructive, for as it is found in the eggs, it is, of course, hereditary, and passes directly from one generation to the next.

M. Pasteur, after long and careful study of the disease and the micro-organism which causes it, suggested means whereby it was possible to detect the diseased eggs, and so insure the health of the subsequent brood, and it is not too much to say that this investigation was the means of saving the sericulture of Europe from the total extinction that threatened it.

The Pasteur system, as carried out in the South of France and Italy, is, briefly, this: Each female silkworm moth is placed in a little muslin bag to lay her eggs. After they are laid, the moth is put into a small glass mortar and crushed with a glass pestle, a few drops of water are added, and a droplet of the water is then transferred to a glass slide, covered with a cover glass, and examined under a microscope. The bacterium, being large, oval, and shining, is very readily detected with a power of about 600 diameters, and, if any corpuscles are discovered, it is certain that the moth was diseased, and the chances are that the eggs will be diseased also. Therefore, whenever the moth is found to be affected, her eggs are at once destroyed; while, on the other hand, if she is seen to have been free from disease, her eggs are kept and used for breeding purposes. There are several large firms which do nothing but produce these selected eggs for sale to the cultivators. One of these establishments employs over 300 microscopists to examine the female moths.

The spread of pebrine has been very great of late years in India, China, and Japan, and the authorities have been trying for some seven or eight years past to introduce the Pasteur system into India, but, hitherto, without any appreciable success. The reasons for this are very simple. The worm grown in Europe is an annual, and between the laying of the eggs and the hatching many months elapse, during which the process of selection can go on. For it is not necessary that the moths be examined at once; they may be kept a long time in a dry state before being placed under the microscope. Now, in India and other tropical countries the worm which is grown is what is called a "multivoltine"—that is, it has many generations in a year, and the time which elapses between the laying of the eggs and the hatching is only from six to seven days, thus limiting the time during which the selection can be carried on to about five days, if the eggs are to be sold as eggs.

The large staff of microscopists which would have to be employed to turn out any considerable quantity of eggs would be so expensive to maintain that from a commercial point of view the system would be absolutely impossible. In addition to this, it appears that to eradicate the disease from these tropical worms, one selection is quite insufficient. The system, therefore, besides being very costly, produces eggs which are by no means to be relied on as being free from disease.

In November of the year 1889 silk culture was started by some Chinese in the State of Perak in the Malayan Peninsula. Pebrine quickly made its appearance and caused serious losses in 1891, and in February, 1892, the enterprise had to be abandoned owing to the ravages of the disease. Shortly after the sickness among the worms showed itself, I tried to apply the Pasteur system to them, and arrived at the conclusion above stated, after about a year's work. In November, 1891, I began another series of experiments, which have led to results which appear to show that there is a way of applying the Pasteur system to the multivoltine silkworms of the tropics both economically and effectively.

My experiment was begun with some cocoons procured from one of the Chinese cultivators, and on a microscopical examination of the female moths, after they had laid their eggs, it was found that they were all diseased. The eggs of the least infected moths were taken and hatched, and the young worms were placed in little china cups, four worms in each. The cups were stood on a table, and they and the table were frequently disinfected during the lifetime of the worms, with a soap solution containing five per cent. of carbolic acid. Before use the house was also thoroughly disinfected by fumigation with sulphur. When any diseased worms were noticed they were at once removed and destroyed. By these means about eighty cocoons were produced, a fair proportion of the moths from which, on microscopic examination, were found to be healthy. By continuing the same procedure for three generations the pebrine was entirely eradicated from the stock, and a healthy breed established. After this, isolation in the cups was no longer necessary.

Up to this stage the experiment proved that microscopic selection coupled with isolation and rigid sanitary precautions would produce in a breed, every individual of which was infected with pebrine, a perfectly healthy race in the course of three generations, or in about four months time.

Continuing the series of experiments, it was proved that eggs laid of these healthy moths, when reared under conditions nearly similar to those which are maintained in the wards of a modern hospital, did not contract the disease during several successive generations, without either microscopic or any other selection. For nearly two years this series of experiments was carried on, and it is believed that the two facts above stated have been, during that time, placed beyond doubt.

To recapitulate, these are, first, that a healthy race may be produced in three generations from a highly diseased one; and secondly, that having once procured a healthy race, simple sanitary precautions are sufficient to guard it from contagion for several successive generations. On these two easily understood and proved facts is based the system here advocated.

This system I will now endeavor shortly to explain. A breed of say 3,000 worms, which, for convenience, may be called "firsts," would be produced in the manner already described, and maintained pure by being microscopically selected at every brood. One microscopist could examine all the female moths of each brood of this number of worms, between the laying and hatching of the eggs. A certain number of the eggs from the best cocoons would be put aside for the next generation of "firsts," and the remaining eggs would be reared in separate houses, in which strict sanitary precautions would be enforced.

This brood, which may be called "seconds," on attaining maturity would lay, but would not be subjected to microscopic selection; and it is these eggs which would be given or sold to the cultivators. They would, therefore, be always only once removed from the "firsts," or microscopically selected eggs.

If 1,200 female moths, out of the 3,000 above mentioned, were passed at an inspection of "firsts," they would yield, say 240,000, or 120,000 female "seconds;" which again would yield 24,000,000 of eggs for distribution. This number of worms would give 16½ tons of "green" or fresh cocoons, and at four broods per annum, say 64 tons, as the outcome of the work of a single microscopist for a year. This is as much as 100 microscopists could do, with multivoltine worms, if working by the ordinary method of selection as practiced in Europe. In the above computation it has been assumed that out of the 355 eggs which an average moth has been found to lay, only 200, or 56 per cent., will attain maturity. This is a large margin to allow, as it has been found by experiment that, having once obtained a pure breed, the mortality among the "seconds" does not exceed 5 per cent.

The success of the whole system depends on guarding from external sources of contagion the generation after that which has been proved to be free from disease by microscopical examination. To do this, cleanliness, the free use of antiseptics, isolation and the growing of the food in a place where it will not be infested by unhealthy worms, are the main points to be attended to. The windows and all the openings of the breeding houses should be covered with wire netting, and in a place much infested with flies all the outer doors should be double to prevent their ingress. The trays might be of zinc, and most of the other things used of the same material. These can be instantly disinfected by plunging into a pan of boiling water, or of carbolic solution, the former for preference. The tray stands should all be made of galvanized, or better, enameled, iron, and the floors either cemented or asphalted. Large houses are to be avoided both for "firsts" and "seconds," as, in case of the outbreak of any disease, small detached houses have such self-evident advantages.

From time to time it might be necessary to introduce fresh blood into the breed, and for this purpose the fresh worms should be microscopically selected for four or five generations before mixing them with the original "firsts," being kept during the probation in a house isolated as far as practicable from all the others. It may be again mentioned that I have found a single selection, never mind how carefully it is done, is insufficient to eliminate pebrine from a race of these tropical worms. Therefore, it follows that it is useless to attempt to produce "seconds" until the "firsts" have been thoroughly purged of all traces of disease by repeated selections.

In an establishment such as is here outlined, the microscopist would be the only highly paid man. All the other work could, after a little time, be done by ordinary coolies, so that the cost of maintenance would be comparatively unimportant, and the eggs could be consequently supplied at a very low price. An establishment employing three or four microscopists would suffice for the supply of a large silk-producing district. The distribution could either be made of the eggs or of the cocoons of the "seconds," so that there would be plenty of time to send them long distances. This is a matter of considerable moment, as it is of the utmost importance that the tending establishment should be as remote as possible from the cultivators. Every mile that intervenes decreases immensely the chances of the appearance of diseases of all kinds among the worms and of the presence of flies and other insect pests that attack them.

I venture to predict that this system, if carried out in the way here indicated, will do for the multivoltine silkworms of the tropics what the system practiced in Europe has done for the annual silkworms of temperate climates.

[Continued from Supplement, No. 951, page 15197.]

THE ART OF BOOK AND NEWSPAPER ILLUSTRATION.*

By Henry Blackburn.

Lecture III.

We come now to the consideration of a class of illustrations in which the artist of the future will have to come more into personal contact with the author than he has been in the habit of doing, and where the distinction I referred to in the first lecture between illustrations which are to be (1) records of facts and (2) works of art should be more clearly drawn.

Here we ask for the active co-operation of the author. The far-reaching spread of education—especially technical art education—is tending to bring together, as they were never brought before in this century, the author and the illustrator. The author of a book will give more attention to the appearance of his pages, to the decorative character of type and ornament; while the average artist will be better educated from a literary point of view, and, to use a French word for which there is no equivalent, more *en rapport* with the author. By means of the cheap processes for reproducing any lines to print with the letterpress in the pages of a book, the author will have the opportunity of explaining himself, by his own notes, diagrams, etc., on the page which he never had before. This is illustration in the true sense of the word.

How false and imaginative many of the pretty illustrations in books, especially books of travel, were, before the days of photography, every one knows. How easy it is to go astray in an illustration, without direct communication with the author of a book, is also well known.

To show how easily the cleverest artists may go astray without the aid of the author, I exemplified the other day, where the verbal description of a scene was read out carefully several times before a company of artists, while three were selected to draw upon blackboards (simultaneously and without seeing each other's work) the principal lines of composition as presented to their minds. Each was, in a sense, a work of art; each differed widely from the other, and all were wrong! The exhibition was highly stimulating and interesting, but the immediate object was to show how useless and absurd many illustrations are in books, as *illustrations*. If they are works of art they may be accepted as worthy decorations of a book; but, in the face of what photography is doing now, there is less and less demand for the imaginative landscape compositions which graced so many books of travel twenty years ago. As to purely imaginative illustrations, in which the mind in them plays the most important part, there is happily plenty of scope for the educated illustrator of to-day. But first as to

THE AUTHOR.

Considering the small amount of interest which the author — whether historian, poet, essayist, man of science, or discoverer—seems to take in the production of his book, and the personal interest with which he might endow it, let me draw a picture of the average author of to-day—or yesterday; the "man of letters," the student, who lives apart from the whirl of journalism and hand-to-mouth literature. The picture may be a little fanciful, but it is intended to be suggestive, not only to the author, but to all who are engaged in the production of books, whether "olde style," or otherwise.

If there be one characteristic which should enhance the interest attaching to the expression of a writer's thoughts, it should be that his individuality, or personality so to speak, should be in some way expressed on the printed page. Chaucer, Shakespeare, Milton, Scott, Byron, Dr. Johnson, and the men of letters of the past, are, each of them, deeply interesting to us in their personality, in their costume, in their handwriting, and in whatever they have left behind them as the work of their own hands. As matters stand at present, the high pressure of work imposed upon any one who has something to say is turning the picturesque figure of the "author" (as we read of him in past times) into a more or less highly strung, pre-occupied, steam-driven "literary machine."

Looking backward to the Victorian age (say from the end of the twentieth century), what pictures will be formed in the minds of those who come after us, of the *entourage* of the man of letters of to-day. Clothed in a degrading, characterless costume, which takes all appearance of manliness and suppleness from his figure, living in houses and in cities in which nearly everything ornate or beautiful has been stolen, borrowed, or copied from another country or period, he is found engaged in the production of books in which, as far as the mechanical parts are concerned, nearly everything is a sham.

The nineteenth century author's love for the literature of his past has led him to imitate not only the style, but the outward aspect of old books; and, by a series of frauds (to which his publisher seems to have lent himself only too readily), to produce something which appears to be what it is not.

The genuine outcome of mediæval thought and style—of patience and leisure—is treated at the end of the nineteenth century as a fashion to be imitated in books, such as are to be seen under glass cases in the British Museum. The twentieth century reader, looking back, will see few traces worth preserving, either of originality or of individuality.

The type founder of to-day takes down a Venetian writing master's copy book of the sixteenth century [which I will show presently on the screen] and, imitating exactly the thick downward strokes of the reed pen, forms a set of movable type, called in printer's language "old face," a style of letter much in vogue in 1893; but the style and character of which belongs altogether to the past. Thus, with such aids, the man of letters of to-day—living in a whirl of movement and discovery—clothes himself in the handwriting of the Venetian scholar as deliberately as the Norwegian disguises himself in a bear skin.

The next step is to present in his book a series of so-called "engravings," which are not engravings. The advance of science in producing blocks, from photographs of steel and other intaglio plates, for the type printing press, at a small cost per square inch, is not only taking from the artistic value of the modern *edition de luxe*, but also from its personal interest and genuineness.

The next step is to manufacture rough edged, coarse textured paper, purporting to be carefully "hand-made." The rough edge, which was a necessity when every sheet of paper was finished by hand labor, is now imitated successfully by machinery, and is handled lovingly by the book worm of to-day, regardless of the fact that these roughened sheets can be bought by the pound in Drury Lane. The worst, and last fraud (I can call it no less) that can be referred to now is, that the clothing—the "skin of vellum"—that appropriately incloses our modern *edition de luxe* is made from pulp, rags, and other *debris*. That the gold illuminations on the cover are no longer real gold, and that the handsomely bound book, with its fair margins, cracks in half with a "bang," when first opened, are other matters connected with the discoveries of science, and the substitution of machinery for hand labor, which we owe to modern enterprise and invention. [Here reference was made to Mr. William Morris' exhibit of books, and to Mr. Cobden Sanderson's bindings.]

But, if it be impossible in these days (and in spite of the efforts of Mr. Wm. Morris and others it seems to be impossible) to produce a genuine book in all its de-

* Three lectures delivered before the Society of Arts, London, December, 1893. From the *Journal* of the Society.

tails, it is worth considering in what way the author can stamp it with his own individuality; also to what extent he is justified in making use of modern appliances.

How far, then, may the author be said to be responsible for the state of things just quoted? Theoretically, he is the man of taste and culture *par excellence;* he is, or should be, in most cases, the arbiter, the dictator to his publisher, the chooser of style. The book is his, and it is his business to decide in what form his ideas should become concrete; the publisher aiding his judgment with experience, governing the finance, and carrying out details. How comes it then that with the present facilities for reproducing anything that the hand can put upon paper, the latter day nineteenth century author is so much in the hands of others as to the appearance of his book? It is because the so-called educated man has not been taught to use his hands, as the missal writers and authors of mediæval times taught themselves to use theirs. The modern author, who is, say, fifty years old, was born in an age of "advanced civilization," when the only method of expression for the young was one—"pot-hooks and hangers." The child of ten years old, whose eye was mentally forming pictures, taking in unconsciously the facts of perspective and the like, had a pencil tied with string to his first two fingers until he had mastered the ups and downs, crosses and dashes, of modern handwriting, which has been accepted by the great as well as the little ones of the earth as the best medium of communication between intelligent beings; and so, regardless of style, character, or picturesqueness, he scribbles away!* So much for our generally straggling style of penmanship. Looking at the handwriting of to-day, what wonder that a writer of any taste or feeling should hesitate to distribute his deformities through the world by means of *fac-simile* reproductions, and yet we desire to see the handwriting of our favorite author. But handwriting in our generation is so singularly mean and inexpressive; it has arrived at such a point of indistinctness and slovenliness among men that (it is sad to say it) refuge is now taken in the American typewriting machine.

Here it may be objected that, in the rapid movement of the world's work and thought, there is no time for considering the effect of a page, that the shorthand writer and the typewriter (one and the same person) should be close at hand to take down what we have to say. This may be so in the merchant's or lawyer's office, the warehouse, the railway station, or the newspaper office, but from a picturesque point of view, let us hope the day is far distant when an author of leisure (as distinct from the journalist) will filter out his ideas in this fashion. Anthony Trollope's record of the working of his own literary machine—of the number of words reeled off in a minute, in an hour, in a day—leaves an unpleasant sense of mechanism on the mind.

But we are told that we are shaking off our trammels, and that all these modern inventions are to set the spirit free; and so, to shorten our journeys on the road to knowledge, we are to have recourse to the "typewriter" and its most monotonous lines! Should we not rather reform our own handwriting, once for all. First study a system of shorthand for rapid notes and then learn to write so clearly and distinctly, that a *fac-simile* of it would be a delight to read on the printed page.

Consider the question in all its bearings. The time has come when, for the first time in the history of the world, any lines drawn or written can be reproduced in *fac-simile*, from which thousands of copies can be printed. There is no occasion to repeat the details; once realize the fact that your handwork can be made to appear clearly on the printed page (with little more expense than typesetting), and you—the young author, student, man of letters—will give us in the future more of your interesting personality. The thoughts may flow as before, but the vessel to receive them and convey them to others shall have its hallmark of individuality.

Thus in the future the distinction will be more clearly drawn between the work of the student on the one hand and journalism, hack literature, and "penny dreadfuls," on the other. Typesetting and uniform printing of words by the thousand will be used as before, but the "author"—for want of a better word—the poet and the scholar, who gives a book to the world, should free himself as much as possible from mechanical trammels, and boldly set to work to present himself in appropriate guise. The beautiful photographic processes which have been perfected during the last few years will *fac-simile* a page so accurately that it is wonderful that so few of our artistic countrymen have availed themselves of them. Had such processes as those now in use in England, France, and Germany been in existence in the time of the early engravers, there would probably have been no such thing as wood engraving, for chroniclers and artists, from the engraver of St. Christopher to Bewick, would have hailed the new methods with delight. What we might have lost or gained artistically cannot be considered now. The question for the moment is how to rouse sufficient interest in these matters among authors.

Let us take the poets first. They have comparatively little to do with the outer world; but the public, rightly or wrongly, is eager to know more of their personality. They, the elder, the professional poets, live, most of them, in an atmosphere of cloistered silence, of repose and picturesqueness, more akin to mediæval times than to railways and telegraphs. They come out to greet us in a garden of flowers, where Nature forms herself into pictures all around. Is it not a poor thing that they can record little or nothing of their surroundings pictorially; no mental impressions except in type-set words? With the exception of the late Lord Tennyson, it is difficult to think of any poet of our day whose personality is well known and cared for by the public. Modern dress, and the fear of appearing to "pose" in these advertising days, has led to the neglect of many outward things which the historian would hold dear.

The moral may well be drawn. Equip yourself in more ways than one for expression by the pen; to you who write, in times when it is impossible to be personally picturesque, remember that anything drawn or written by your own hand may be of interest in the future. These are things that the artist, as well as the author, may bear in mind, as in the future they will work much more in concert and consider together the setting out of a page, the harmony of text and illustrations, and appropriate ornament on page and binding.

Is the "setting out of a page" one of the lost arts, like the designing of a coin? What harmony of style do we ever see in an ordinary book? [Here reference was made to exhibits.] How many authors or illustrators of books show that they care for the "look" of a printed page? The fact is that the modern author shirks his responsibilities, following the practice of the greatest writers of our day. There are so many "facilities"—as they are called—for producing books that the author takes little interest in the matter. Mr. Ruskin, delicate draughtsman as he is known to be, has contributed little to the *ensemble* or appearance of the pages that flow from the printing press of Mr. Allen, at Orpington. How well his books are printed you can see presently, but judged by the past a deadly monotony pervades the page; the master's noblest thoughts are printed exactly like his weakest, and are all drawn out in line together as in the making of macaroni! Mr. Hamerton, artist as well as author, is content to describe the beauty of forest trees, ferns and flowers, the variety of underwood and the like (nearly every word, in an article in the "Portfolio," referring to some picturesque form or graceful line), without indicating the varieties pictorially on the printed page. Tennyson and other poets have been content for years to sell their song by the line, little heeding, apparently, in what guise it was given to the world; and so the monotony of uniformity pervades the pages, alike, of great and small, and a letter from a friend is now often printed by a machine! The last stage of feebleness and admission of incompetence in the matter of using our hands, which I may touch upon here, seems to have been reached in the indiscriminate use of the typewriter; for which, as a satirical writer lately remarked, "there is something to be said, as many of our scientific friends have been able to communicate their ideas in a letter, for the first time, by this means."

Let us now look at some slides, in illustration of what I have called the "decorative page," with and without pictorial illustrations.

1. Example of early Venetian writing, from a copy book of the fifteenth century, written with a reed pen. See the clearness of the page and its picturesqueness; also its similarity to the type letters used today—what are called "old face"—the origin of what is known as Caslon type, and of much (good and bad) letter in modern books.

2. A beautiful example of Gothic writing and ornament, from a French illuminated manuscript in the British Museum; date 1480. Here the decorative character and general balance of the page is delightful to modern eyes.

3. *Fac-simile* of a printed page, from Polydore Vergil's "History of England," produced in Basle in 1556. The style of type is again familiar to us in books published in 1893; but the setting out of the page, the treatment of ornament (with little figures introduced, but subservient to the general effect), is not familiar, because few of us can produce a decorative page. The printer of the past had a sense of beauty, and of the fitness of things, apparently denied to all but a few to-day.

4. An illuminated printed page, 1521, with engraved borders, after designs by Holbein; figures again subordinate to the general effect.

5. Example of a page, Italian, fourteenth century; ornament, initial, and letters forming a brilliant and harmonious combination.

In all these pages, it will be observed, what is called "color" in black and white is preserved throughout. Closely criticised, some of these block designs may appear crude and capable of more skillful treatment, but our object is to study the effect of a page without "illustrations," in the modern sense of the word, to see how color and breadth is obtained in pure line. In these and similar pages, such, for instance, as "Le Mer des Histoires," produced in Paris by Pierre le Rouge in 1488, the harmony of line drawing with the type letters is most interesting and instructive at the present time. It may be attained in line, but never in wash drawings, reproduced by the processes.

It is in the production of the decorative page that wood engraving asserts its supremacy still, as may be seen in some beautiful books produced in England during the past year, which we will examine after the lecture. Mr. William Morris' books, which he has kindly lent us—where artist, wood engraver, type founder, paper maker, printer and book binder work under the guiding spirit (when not the actual hand work) of the author—have been fully described elsewhere. They are interesting to us rather as exotics; an attempt to reproduce the exact work of the past under modern conditions; conditions which render the price within reach only of a few. But they are at least a protest against the modern shams of which I have spoken to-night.

From an economic and practical point of view, and as a new departure in modern illustration, I would rather point to the work produced by an art school, where an educated and intelligent mind seems to have been the presiding genius; where the illustrators, while they are fully imbued with the spirit of the past, have taken pains to adapt their methods to modern requirements. I refer to the Birmingham Municipal School of Art. While using wood engraving freely, the illustrators of Birmingham, notably Mr. Gaskin, have shown, as in the page before you, what can be done in line drawing by the relief processes, to produce color and ornament which harmonize well with the letterpress of a book. [Slide of page from Mr. A. J. Gaskin's illustrations to "Hans Andersen's Fairy Tales."] This seems an important step in the right direction, and if the work emanating from this school were less, apparently, confined to an archaic style, the heavy outline and mediæval ornament (I speak from what I see, not knowing the school personally), there are possibilities for an extended popularity for those who have worked under its influence.

[Continuing the remarks on the modern decorative page, two slides were shown of pages designed by Mr. Walter Crane, "The White Snake" and "The Geese and the Cranes." Mr. Crane's pages were cited as excellent modern examples of style, in which harmony of text and illustration have been considered. It was pointed out here how unsuitable steel engravings and fine wood cuts appear when in close juxtaposition with the type of a book.

Other slides were then shown on the screen, one of the most interesting being the enlargement of an American wood engraving from the October number of the *Century Magazine;* also a title page to an American edition of "She Stoops to Conquer"—design and lettering all drawn in pen and ink by Mr. Alfred Parsons, and reproduced by an intaglio process.]

Referring, further, to wood engraving, Mr. Blackburn said: As regard wood engraving generally in the year 1893, one has only to point to this frontispiece from the *Century Magazine*, and to continual arrivals of new illustrations from the other side of the Atlantic, to prove that wood engraving as an art, in qualities of delicacy, tone, and color, has never b en excelled. The artistic excellence of American engraving is, as we all know, a matter of capital and energy; the enormous circulation of their magazines enabling the proprietors to give wood engravers the best education possible (in Paris and other capitals of Europe), placing them on a social level with the illustrator, a very important point. Another powerful factor is the excellence of American printing.* Mr. J. Comyns Carr, lecturing in this room in May, 1882, when the possibilities of process work were less understood than now, said:

"Book illustration as an art is founded upon wood engraving, and it is to wood engraving that we must look if we are to have any revival of the kind of beauty which early printed books possess. In the mass of work now produced there is very little trace of the principles on which Holbein labored. Instead of proceeding by the simplest means, our modern artist seems rather by preference to take the most difficult and complex way of expressing himself. A wood engraving, it is not unjust to say, has become scarcely distinguishable from a steel engraving, excepting by its inferiority."

This was said more than eleven years ago, and referred especially to the elaborate and beautiful wood engravings which came from America. Speaking now, in 1893, we are bound to say that the art of wood engraving has not progressed in England in the last ten years, and that the simplicity and individuality of such work as that of Bewick is rarely to be seen in the pages of our printed books With the fine examples by Mr. W. Biscombe Gardner, and other engravers (which we shall see after the lecture), I must leave this part of the subject. Time only prevents me from mentioning other books published in England in 1893, in which artist, engraver and printer have worked well together.

In conclusion then, let me say that every one who cultivates a taste for artistic beauty in books, be he author, artist, or artificer, may do something toward relieving the monotony and confusion in style which pervades the outward aspect of so many books. It is a far cry from the work of the missal writer in a monastery to the pages of a modern book, but the taste and feeling which was shown in the fifteenth and sixteenth centuries in the production of books exist in the nineteenth (as we know), but under the difficult conditions of our times.

Many years ago the question was asked in the *Athenæum*, "Why is not drawing for the press taught in our government schools of art?" I think the principal reasons why the art of illustration by the processes is not generally taught in art schools are (1) drawing for reproduction requires more personal teaching than is possible in public schools; (2) the art masters throughout the country (with very few exceptions) do not understand the new processes, which is not to be wondered at.

It is not the fault of the masters in our schools of art throughout the country that students are taught in most cases as if they were to become painters, when the only possible career for the majority is that of illustration or design. The masters are, for the most part, well and worthily occupied in giving good groundwork of knowledge to every student, as to line drawing. There is no question that the best preparation for this work (*pace* the paragraph from the *Athenæum*) is the *best general art teaching that can be obtained.* The student must have drawn from the antique and from life; he must have learned the elements of composition and design; have studied from nature the relative values of light and shade, aerial perspective and the like; in short, have followed the routine study for a painter whose first aim should be to be a master of monochrome.

In the more technical parts which the young illustrator by process will require to know he will need more personal help than is easily obtainable in classes in schools of art. He will have a multitude of questions to ask "somebody" as to the reasons for what he is doing; for what style of process work he is by touch and temperament best fitted, and so on. All this has to be considered, if we are to keep a good standard of art teaching for illustration.

In the book of the future we hope to see less of the "lath and plaster" style of illustration, as produced from careless wash drawings by process; fewer of the blots upon the page, which the modern reader seems to take as a matter of course. In books, as in periodicals, the illustrator will have to divest himself, as far as possible, of that tendency to scratchiness and exaggeration that injures so many process illustrations, as pointed out in the first lecture. In short, he must be more careful, and give more thought to the meaning of his lines, to the adequate expression of textures and the like. There is no reason why the texture of a man's coat should look like straw, or the background to a figure have the appearance of fireworks. No amount of ability on the part of the artist will make these things tolerable in the near future.

In "the book of the future" the author may do

* It may not be generally known that in order to cover four average pages of a lady's letter, the point of the pen has had to travel over a distance of nearly one hundred feet.

* Here it should be remarked that the artist who draws for the processes in this country must not expect (excepting in very exceptional cases) to have his work reproduced and printed, as in America. He must learn to adapt himself to other conditions; this, apparently, few artists or teachers seem to realize.

more than he has ever done, as I have already suggested; a volume of instances might be given where a writer's meaning could be more clearly expressed pictorially than verbally. The subject is not half ventilated yet, nor can I touch upon it further to-night; the day is not far distant when the power of the hand of the author will be tested to the utmost, and lines of all kinds will appear in the text. There is really no limit to what may be done with modern appliances, if only the idea is seized with intelligence; the journalist of the future will also aid unconsciously in the formation of a new language, which every nation can understand.

In conclusion, Mr. Blackburn said: In thus considering the education of the illustrator of to-day, I need hardly remind you of several modern books which come greatly to his aid. Three of the first importance are: "The Graphic Arts," by P. G. Hamerton (London; Macmillan & Co.); "Pen and Pencil Artists," by Joseph Pennell (London: Macmillan & Co.); "English Pen Artists of To day," by J. G. Harper (London: Rivington, Percival & Co.)

The value and comprehensive character of Mr. Hamerton's book is well known, but it reaches into branches of the art of illustration far beyond the scope of these lectures. Of the second, it may be said that Mr. Joseph Pennell's book is most valuable to students of "black and white," with the caution that many of the illustrations in it were not drawn for reproduction, and would not reproduce well by the processes we are considering. The third volume seems more practical for technical purposes.

It is to be regretted that these books are so costly as to be out of the reach of most of us; but they can be seen to advantage in the library of the South Kensington Museum.

Mr. Hamerton's "Drawing and Engraving, a Brief Exposition of Technical Principles and Practice" (London: Adam & Charles Black, 1892), and "The Photographic Reproduction of Drawings," by Col. J. Waterhouse (London: Kegan, Paul & Co., 1890), are both portable and useful books, full of technical information. Sir Henry Trueman Wood's "Modern Methods of Illustrating Books" is also an excellent little manual, but its date is 1886.

EDMOND FREMY.

EDMOND FREMY.

FRENCH science has just lost one of its most worthy representatives in the person of an illustrious master, Edmond Fremy, who died on the 3d of February in his apartments at the Museum of Natural History, after a long illness, at the age of eighty years. The career of this learned man was one of the longest, finest and best sustained that can be found among those of such men as have honored their country.

Fremy was born at Versailles on the 28th of February, 1814. The sciences had always been held in honor in his family, and he was reared with touching solicitude by his father, who was a man of much merit and a professor of chemistry at the School of Saint Cyr. After finishing his studies Fremy became preparator of the lectures of Gay Lussac at the Polytechnic School, at which, at this epoch, Pelouze was an assistant professor. He soon caused himself to be remarked by his ardor in work, by the qualities of his intelligence and by his rare experimental ability. Later on he succeeded, at the Polytechnic School and College of France, Pelouze, who had become professor at these two establishments.

The young professor did not stop here; he replaced Gay Lussac for some time at the Museum of Natural History, and finally succeeded his two masters in 1843 and 1850. Before occupying the chairs of chemistry of the Polytechnic School and the Museum, he had delivered courses of lectures at the Central School and School of Commerce. His diction was clear and his elocution easy. He had, nevertheless, preserved the somewhat pompous form of discourse that was in favor at the beginning of the century. Despite these multiple blemishes of the professorship, he devoted himself to numerous researches in his laboratory. His labors were generally crowned with success, and his important discourses, which we shall enumerate further along, soon placed him in the rank of the most distinguished chemists of our epoch. In 1857 he succeeded Baron Thenard as a member of the Academy of Sciences. In 1879 he succeeded Chevreul in the direction of the Museum. It was while he was at the head of this establishment that the grand gallery was inaugurated and that the great laboratories of Buffon Street were opened.

Decorated with the cross of the Legion of Honor in 1844, the eminent scientist was promoted as officer in 1862 and commander in 1878.

Fremy leaves behind him a rich collection of works and new applications. His first memoirs date back to 1835. They concern the precious metals, gold and silver, and the rare and little known metals of the platinum group. His researches upon ozone, in collaboration with Becquerel, upon the ammoniacal bases of cobalt, upon the fluorides and upon the syntheses of the crystallized minerals successively attracted attention, and at times contributed to the progress of the industrial arts.

We owe to Fremy important works in organic chemistry. He added new facts to the history or the productions of fatty acids and of saponification. He studied the balsams, resins, gums and pectic substances, and was enabled to throw a bright light upon every subject whose study he undertook. He devoted himself particularly to the study of the immediate principles contained in plants. Contrary to the opinion of Payen, he showed that the cellulose genus, so to speak, comprises several different species, and he characterized vasculite, the origin of the ulmic substances. He likewise extended his investigations to the products derived from animals. We are indebted to him for an extended work upon the composition of bones.

Fremy did not confine himself to the study of pure science, but took part in great exploitations.

Director of the Saint Gobain works, he was able to introduce improvements into the manufacture of soda, sulphuric acid, glass, and of the products that are the basis of modern industries. He devoted himself, again, to numerous researches upon steel, cast iron and gun metal, and he discovered an alloy of iron and steel of remarkable tenacity. Toward the end of his life our chemist, with Mr. Verneuil, one of his pupils, published the results of his labors upon the artificial production of rubies. The numerous specimens of crystals that he obtained by synthesis were exhibited by him in one of the rooms of his apartments at the Museum. This was his last work.

We have just seen that Fremy has rendered the greatest services to applied chemistry, but it must not be forgotten that during his long career he likewise played an important *role* in experimental instruction.

From the time of his entering the Museum he opened his laboratory freely to all young chemists who presented themselves to him. Several of our scientific celebrities are included among his pupils. Cloez, who died a few years ago while examiner at the Polytechnic School, was one of Fremy's pupils. Mr. Deherain, a member of the Academy of Sciences, entered Fremy's laboratory in 1850, and remained there for several years. Later on, the experimental method of teaching chemistry had become very greatly developed when Fremy was able to open to it the vast laboratories of Buffon Street. Mr. Moissan, member of the Academy of Sciences, made his *debut* in the new laboratories before becoming a pupil to Mr. Deherain. Messrs. Etard, Verneuil and Ogier experimented in Buffon Street under the immediate direction of Mr. Terrell, who was Mr. Fremy's assistant for forty years.

Fremy's publications were very numerous and of the greatest utility. The *Traité de Chimie*, in six large volumes, by Pelouze and Fremy, long remained the fundamental work of classic instruction. In 1881 Fremy began the publication of a vast encyclopedia of chemistry, which was done under his direction, with the collaboration of the most competent scientists, and which is now finished.

Fremy published more than a hundred memoirs in the *Comptes Rendus* of the Academy of Sciences and in the *Annales de Chimie*.

Among his works we may mention, in addition, Lectures on Oxygen and Ozone, Gun Metal, and his last and well edited work on the Synthesis of the Ruby.

After Fremy, having already reached an advanced age, became incapable of continuing his functions as director of the Museum, he was put on the retired list. He felt extremely annoyed at this, and so much the more so in that the administration, assuredly ill-inspired, suppressed his chair and closed his laboratory. Dating from this time he, who had been up till then very sociable and sprightly and a brilliant conversationalist, became morose and taciturn. He lived in solitude up to the time of his death.

The work that he leaves behind him will not perish. He was a worthy man, who, during his long existence, disseminated useful discoveries and fecund labors, and his memory is worthy of our gratitude.—*La Nature.*

THE PRESERVATION OF INFUSIONS.*

By EDMUND WHITE, B.Sc.

THE preservation of infusions, in common with other organic fluids, is dependent upon the exclusion of various organisms—chiefly moulds and bacteria. The preservative action of alcohol is due to its inhibitory action on the life processes of any organisms which may gain access; that is to say, alcohol is an antiseptic. The addition of alcohol or other antiseptic is attended with disadvantages so obvious as to need no mention here. It has always seemed to me that there was ample room for the application in pharmacy of the comparatively recent results of biological research. Thus it is a simple matter for the bacteriologist to preserve for all time his culture media, which, under ordinary conditions, rapidly putrefy. It is also a well established fact that an organic fluid once sterilized will remain unchanged if protected from the access of fresh organisms. The result of some experiments in this direction I now publish.

Preservation of Infusions Without the Addition of Antiseptics.

In November, 1892, some infusion of gentian was made. An 8 oz. flask (A), containing 2 oz. distilled water, was then boiled for ten minutes, and some of the infusion strained into it after turning out the residual water. The neck was instantly plugged with sterilized cotton wool and the flask set aside. The infusion remained good for five weeks, and then some filamentous mould appeared. Immediately this was observed, the contents of the flask were raised to the boiling point and the mould destroyed. The infusion has remained unchanged ever since.

Another flask (B) was filled at the same time, November, 1892. It was thoroughly washed, some fresh infusion of gentian placed in it, the neck being plugged with cotton wool. After bringing the infusion to the boiling point and continuing the ebullition one minute, the flask was set aside, the cotton wool plug being heated in the flame till it singed slightly, in order to completely sterilize it. This infusion has remained absolutely unchanged for fifteen months, and has been examined for bacteria at intervals, with negative results.

Some infusion of ergot was made on January 29 last, the flask (C) being previously sterilized by boiling water in it immediately before pouring in the infusion. The contents are therefore seventeen days old, and have shown no sign of decomposition. A further quantity of infusion of ergot was made on January 29 last, but the infusion was boiled after introduction to the flask (D). This also remains unchanged.

Other flasks (E and F) contain infusion of buchu, the manipulation being the same as for flasks C and D respectively. The results are the same also.

Infusion of calumba made twelve days ago has been sterilized by filtration through a kieselguhr block of the Berkefeld Filter Company, and received directly into a flask (G) which had been just previously sterilized by boiling distilled water in it. The filtering block and its connections were boiled in water just before filtration, the neck of the flask being afterward plugged with sterilized cotton wool as in the other experiments. Some infusion of calumba was filtered in the same way and at the same time as that in G, into a flask (H) cleaned in the ordinary way only, and not sterilized by boiling water. The result is entirely different. After three days a faint turbidity appeared, which has continually increased, until now the infusion is absolutely putrid. The difference between the two experiments, G and H, was that the flask, G, was sterilized and H was simply cleaned under the tap.

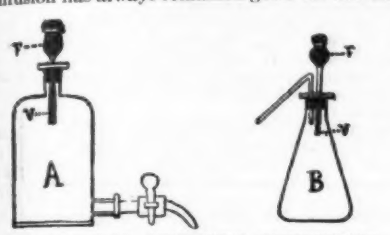
These experiments show, I think, that the pharmacist may do a great deal toward the abolition of the so-called concentrated infusion. For instance, a quantity of freshly made infusion may be filled into flasks of convenient size, the flasks having been previously sterilized in the manner described, and the necks immediately plugged with cotton wool recently heated to 120°–150° C., say in an ordinary kitchen oven. It would probably be safer to raise the contents of the flasks to the boiling point before putting them aside, but unless they are required to be kept a long period this will be unnecessary. Any loss of aroma through the cotton wool plug may easily be prevented by placing a rubber cap, such as is used for bacteriological purposes, over the mouth of the flask.

The method by filtration through kieselguhr gives more trouble, but it enables one to present infusion of calumba or quassia in exactly the condition required by the Pharmacopœia, the application of heat being quite unnecessary if the filtration be properly carried out.

In place of preserving the infusion in a series of small

* Paper read before the Chemists' Assistants' Association.—*Pharm. Jour.*

flasks, one larger one may be employed, like the one illustrated. It has a well-fitting rubber stopper pierced with two holes, through one of which passes a thistle funnel plugged with sterilized cotton wool, and terminating just inside the stopper. The end is constricted to a narrow orifice to prevent the infusion wetting the wool when the flask is turned up, or a simple valve made from rubber tubing may be attached. The other hole receives a tube bent downward and six or eight inches long, terminating likewise just inside the stopper. A few ounces of water is first placed in the flask and boiled for ten minutes. The residual water is then turned out and replaced by the fresh infusion. Whether it is necessary to raise the contents to the boiling point after introduction will depend partly on the nature of the infusion, and still more on the care which has been exercised in preparing the flask and infusion. When any of the infusion is required it is simply necessary to turn up the flask and let it run out of the bent delivery tube, air flowing into the flask, to replace the liquid poured out, through the cotton wool plug in the thistle funnel. The entrance of organisms is thus prevented. For extra safety the open end of the delivery tube when not in use may be closed with a piece of rubber tubing and a clip. I have several times filled a flask of this kind with some infusion and poured out a few ounces daily, just as if it were required for dispensing purposes. The infusion has always remained good till the end.



VESSELS FOR STORING INFUSIONS.

A, stock bottle; B, flask for dispensing purposes; V, rubber valve; F, thistle funnel, filled with cotton wool.

I have followed a similar plan in the case of infusions—say buchu—where about two gallons is required every week. A bottle provided with a tubulure at the bottom, through which passes a glass tap or tube and clip, and holding a little over two gallons, is thoroughly cleansed and then rinsed several times with freshly boiled and cooled distilled water. The infusion is placed in the bottle and the mouth closed by a good cork, through which a thistle funnel, plugged with cotton wool, passes, in order to admit air as the contents are drawn off. It is by this means easy to keep an infusion from two to four weeks, which would go bad in as many days if stored without these precautions.

The conclusions to which these experiments lead are as follows:

1. An infusion prepared with boiling water is sterile when perfectly fresh, if care be taken to avoid unnecessary exposure.

2. The infusion so prepared may be kept sterile in a flask in which water has been recently boiled.

3. Raising the contents of the flask to the boiling point after plugging renders their preservation more certain.

4. Cold infusions may be sterilized by filtration through kieselguhr blocks.

Preservation of Infusions by the Addition of Antiseptics.

The addition of antiseptics to ordinary infusions is, of course, inadmissible, but the so-called concentrated infusions usually contain 15 or 20 per cent. of rectified spirit. The two chief objections to this addition are (1) the cost of the alcohol, and (2) the alteration in physical character which is produced by its addition. In several discussions on the preservation of infusions and fluid extracts, chloroform has been mentioned, but generally dismissed as altogether without the pale of discussion. This, I venture to think, is a great mistake. For instance, I produce a concentrated infusion of senega, preserved by the addition of 1 in 400 by volume of chloroform. Fluid extracts may be preserved equally well without the use of alcohol. One fluid drachm contains, therefore, one-seventh of a minim of chloroform, a quantity surely too small for any objection to be raised to its presence. If the infusion contained alcohol as a preservative, the same dose would probably be equal to 15 minims of rectified spirit. The diluted chloroformed infusion would contain 1 in 3,200 of chloroform, equal to a half drachm of chloroform water in one ounce. This amount of chloroform has a very slight taste, even in plain water, and in presence of other flavors becomes practically indistinguishable. Moreover, the addition of 1 in 400 of chloroform produces no precipitate and no change in the physical appearance of the fluid, such as follows the addition of 15 or 20 per cent. of rectified spirit. The relative cost of chloroform and rectified spirit, when used in the proportions I have mentioned, is about 1 to 80, if 20 per cent. of rectified spirit be used. In using chloroform the greatest care must be taken to prevent any contamination or incipient decomposition before the addition of the preservative to the finished product. Where admissible, it is a good plan to raise the finished fluid to the boiling point in order to sterilize it, and then add the chloroform as soon as it is cold.

My own experience has proved that chloroform might advantageously replace alcohol as a preservative in many pharmaceutical preparations.

FRESH WATER FROM SALT WATER.

By A. NORMANDY, Essex, England.

THIS is an apparatus for producing fresh from salt water by a system of multiple evaporation. Steam is produced from salt water in an ordinary boiler, and led into a condensing chamber surrounded by cold salt water, which is evaporated by taking up heat from the condensing steam. The vapor from this chamber is treated similarly in a second vessel, and the result again in a third; the water vapor from the last operation is finally condensed in an ordinary condenser. The condensed fluids from all the chambers are run together under certain regulations, and the supply of salt water to each chamber and to the boiler is regulated by means of floats, which are governed by the effluent condensed water from each casing; the supply to each casing being regulated by the water issuing from the next condensing vessel.

ANALYSES OF NATURAL GAS.

CONSTITUENTS.	Fredonia, N. Y.	Sheffield, Warren County, Pa.	Kane, McKean County, Pa.	Wilcox, McKean County, Pa.	Speechly, near Oil City, Pa.	Lyons Run, Murrysville, Pa.	Raccoon Creek, Pa.	Houston, near Canonsburg, Pa.	Murrysville, Pa.	Pittsburg Exhibition Grounds, Pa.	Cleveland, O.	Creighton, Pa.	Pointer & Co.'s Well, Pittsburg, Pa.	Baden, Pa.	Kokomo, Ind.	Allegheny City Salt Well	Vancouver, British Columbia
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
Nitrogen	9·54	9·06	9·79	9·41	4·51	2·02	9·91	15·30	4·40	7·30	6·50	0	0·70	12·32	6·00	7·10	6·30
Carbon dioxide	0·41	0·30	0·20	0·21	0·05	0·28	trace	0·44	0·20	0·52	0·00	3·64	0·40	0·41	0·40	0·30	0·14
Hydrogen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxygen	trace	trace	trace	trace	trace	trace	trace	trace	trace	trace	0	0	0	0	0	0	0
Sulphureted Hydrogen	0	0	0	0	0	0	trace	0	0	0	0	0	0	0	0	0	0
Paraffins	90·05	90·64	90·01	90·38	95·44	97·70	90·09	84·26	95·40	92·18	93·50	96·36	98·90	87·27	93·60	91·60	93·56
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
The paraffins contained in these gas samples have the following composition by weight																	
Carbon	78·14	76·69	76·77	76·52	77·11	74·96	76·42	76·68	75·15	75·40	76·40	75·80	75·51	76·48	75·40	75·44	75·23
Hydrogen	21·86	23·31	23·23	23·48	22·89	25·04	23·58	23·32	24·85	24·60	23·60	24·20	24·49	23·52	24·60	24·56	24·77

Nos. *1, 2, 3, 4, 5, 6, 7, 8, 14* are cited from *Report of Geol. Survey of Penna.*, 1886.
Tests were made at the wells in all cases excepting Kokomo and Vancouver. In the case of these 2 localities samples were very carefully taken and forwarded by Mr. E. C. Somers (Kokomo) and Mr. C. F. Hutchings (Vancouver). (All the analyses were by F. C. P.)

CHEMICAL PROPERTIES OF GASES.*

By FRANCIS C. PHILLIPS.

(I) COMPOSITION OF NATURAL GAS.

THE gas used in the following trials was that supplied to Allegheny by the Allegheny Heating Company, and is the product of wells scattered over a considerable gas-producing area. It may be said to represent the average composition of an enormous volume of gas. No important differences have been observed during the period from 1886 to 1892 in the heating or illuminating power of the gas as supplied to the city, except that the odor of petroleum (*i. e.*, of higher paraffins) has been occasionally stronger.

Tests have also been made of gas from various localities in Pennsylvania, New York and Indiana, and Vancouver, British America, and also at Cleveland, O.

In all cases where possible the tests were made at the wells. When this could not be done, it was necessary to use samples brought in glass vessels to the laboratory. In such cases, the samples were examined for oxygen before being subjected to the tests. As a leak in a sample vessel invariably causes an interchange of air and gas, so that air enters in proportion as an escape of gas occurs, much dependence is to be placed on the presence or absence of air in a gas sample as a criterion of its purity.

Hydrogen.—Hydrogen is almost always mentioned in the published analyses of natural gas. I have made the following chemical tests: The natural gas, as supplied to Allegheny by the Allegheny Heating Company, was caused to flow through a solution of palladium chloride for periods varying from 10 days to 3 months; 500 feet have been used in a single experiment. Similar tests have been repeated at various times between January, 1886, and May, 1892; but in no case was a trace of precipitation observed in the palladium chloride solution. Natural gas was found likewise to be without action upon solutions of platinum chloride and ammoniacal silver nitrate. A stream of natural gas has been passed through dry pure palladium chloride. This extremely delicate test has failed to show the presence of hydrogen even in traces, although tried repeatedly during the period from January, 1886, until May, 1892. As already stated, the results of my study of gas reactions show that palladium chloride produces very different effects according as it is used dry or in solution. Palladium chloride dry is reduced promptly by dry hydrogen when the gas is used in a free state.

The same salt in solution is slowly and incompletely reduced by hydrogen, although it is rapidly reduced by olefines and carbon monoxide. Similar tests with palladium chloride, both dry and in solution, made at the wells, in the cases of all the localities mentioned in the Table No. 1 from 1 to 14, have led to similar results. Natural gas from Vancouver and from Kokomo, Ind., could not be tested at the wells. Tests made in the laboratory, of the samples received from those localities, gave the same negative results.

Another method of testing for hydrogen has been employed. As is well known, a jet of hydrogen is immediately ignited by platinum asbestos. Natural gas under similar conditions is not ignited, even when the gas jet and the platinum sponge are mounted in an oven kept at a temperature approaching 300°. In order to ascertain the effects of different proportions of hydrogen and natural gas, a gasometer containing the gas mixture to be tried was connected with a jet in form of a drawn-out glass tube, above which some platinum asbestos was fixed. The gas pressure could be so regulated as to produce a pointed flame 1 in. long. By momentarily shutting off the gas by pinching the hose, the flame could be extinguished, and the gas, being turned on again, played against the platinum asbestos. The length of the flame when the gas stream from the jet was ignited was therefore a measure of the gas flow. The gas was ignited by the platinum asbestos or not, according as the proportion of hydrogen in the natural gas was greater or less. The ignition of the gas was also dependent upon the temperature of the oven in which the jet and the platinum asbestos were fixed.

Mixtures of hydrogen and natural gas produced glowing of the platinum and ignition of the gas at the following temperatures, when the experiment was made in a large iron oven whose temperature could be readily measured. The gas pressure was the same in all trials.

Proportion of Hydrogen and Natural Gas.		*Temperatures of the Oven at which the Gas Inflames as it Strikes the Platinum Asbestos.*
Natural gas	95	40–50°
Hydrogen	5	
Natural gas	97·5	80–90°
Hydrogen	2·5	
Natural gas	99	180°
Hydrogen	1	
Natural gas	99·5	210–220°
Hydrogen	0·5	
Natural gas	99·75	270°
Hydrogen	0·25	
Pure natural gas		270–290°

The observed temperatures naturally vary with the pressure, size of jet, etc., but trials with different pressures showed greater constancy than could be anticipated from a method so rough in appearance. The results corroborate those obtained by the more delicate tests. Experiments have also been tried with mixtures of air and natural gas which were exposed to palladium asbestos contained in glass tubes heated in the iron oven described under "Oxidation Temperatures of Hydrocarbons." It has been repeatedly shown that, under such conditions, moisture is only produced at temperatures approaching or higher than the melting point of cadmium iodide.

The absence of free hydrogen has interfered with the use of natural gas in gas engines. The prompt, sharp explosion of coal gas, so necessary for these motors, cannot be produced in the case of natural gas, which requires a higher temperature for its ignition, and explodes with less suddenness, owing to the absence of hydrogen.

The electrical devices for the igniting of coal gas jets in dwellings by the spark of an induction coil have not been so successful where natural gas is used, owing to the higher temperature of ignition of a gas consisting of paraffins and containing no hydrogen. In laboratories where natural gas is the fuel, chemists have experienced the inconvenience that Bunsen burners and blast lamps do not produce the high temperature easily obtained when coal gas is used. Ordinary glass combustion tubing cannot be softened by the employment of natural gas in a Berzelius blast lamp.

A coal gas flame owes its steadiness and stiffness to the hydrogen which the gas contains. Natural gas flames are much less steady and more easily extinguished by air currents.

During May, 1892, a change occurred in the composition of the natural gas supplied to Allegheny City. The gas since that time and up to November, 1892, has been found to contain hydrocarbons which reduce dry palladium chloride. These hydrocarbons are removed completely by digestion with fuming sulphuric acid, so that the gas after this treatment does not reduce palladium chloride. The nature of these hydrocarbons I have been unable yet to determine.

Olefines.—Palladium chloride, iridium chloride, cerium dioxide in sulphuric acid, osmic acid, all remain unchanged by natural gas cold or at 100°. Potassium permanganate is attacked with extreme slowness.

Bromine water has been repeatedly tried. The solution was in some cases cooled by ice to check evaporation of the bromine and in others the bromine was added slowly, drop by drop, to compensate for its evaporation. In no case were any oily drops produced. Prof. Sadtler, of Philadelphia, has in one instance obtained a considerable amount of heavy oil by the action of bromide on natural gas.

My experiments seem to prove the absence of ethylene, propylene, isobutylene and trimethylene from the gas supplied to Allegheny. The same is true of gas from the localities mentioned in the table from Nos. 1 to 17. Tests could not be made at the wells in the case of gas from Kokomo, Ind., and Vancouver, British Columbia; but samples brought to the laboratory gave similar results.

The very low illuminating power of natural gas of Western Pennsylvania is a further evidence of the absence of olefines which, as well known, are remarkable for the brilliancy of the light which they produce. By the kindness of Mr. J. W. Patterson, Gas Inspector of Allegheny County, I am able to give the following data as to illuminating power.

The gas supplied to Pittsburg by the mains of the Philadelphia Company, November 30, 1892, possessed an illuminating power equal to $10\frac{4}{10}$ candles per 5 feet of gas burnt per hour (mean of 10 determinations).

On the same date the illuminating power of the natural gas supplied by the People's Natural Gas and Pipeage Company was $10\frac{7}{10}$ candles.

Mr. Patterson's tests were made with a 36 hole Argand burner, having a chimney 7 in. long.

Acetylene and Allylene.—Palladium chloride solution is unchanged, as already stated. Cerium dioxide, mer-

* Read before the American Philosophical Society, March 17, 1893.—*Light, Heat and Power.*

curic chloride, gold chloride, silver nitrate, ammoniacal cuprous chloride and osmic acid are all unchanged. Hence in the gas I have tested, it may be said that no hydrocarbons of the acetylene series occurred.

I have found no reference to acetylenes in any published analyses to which I have had access.

Carbonic Oxide.—Carbonic oxide is nearly always stated to occur in the published analyses of natural gas.

In my experiments, palladium chloride, gold chloride, silver nitrate in ammonia, iridium chloride, rhodium chloride, osmic acid, all used in solution, were unchanged.

Experiments have been made with Allegheny City natural gas in the following way: Gas has been caused to bubble for five weeks through ammoniacal cuprous chloride solution. This solution was then largely diluted with water and boiled. The gases expelled were collected and tested by palladium chloride solution; but no carbon monoxide was found. It is true that, since the absorption of carbon monoxide in cuprous chloride has been shown to be a case of mechanical solution rather than chemical union, and that the absorbed CO can be expelled by a stream of other gases, the use of cuprous chloride for the absorption and recognition of carbon monoxide cannot be implicitly depended on. Still, the direct tests above named lead me to the conclusion that no carbon monoxide occurs in our natural gas.

Paraffins.—That the lower paraffins occur in natural gas needs no proof. Methane is the chief constituent. Small quantities of higher paraffins are usually present.

Sulphur Compounds.—Pennsylvania natural gas does not contain recognizable quantities of either COS, CH_3SH or $(CH_3)_2S$. Toward the western boundary of the State it is possible that minute traces of sulphureted hydrogen occur. The quantities of all such compounds are far too small to allow of their being easily identified, even in the case of large volumes of gas. The extreme delicacy of the reaction of methyl mercaptan toward palladium chloride would render it possible to detect exceedingly minute quantities of this compound, should it occur.

I have not had an opportunity to test the gas from the Western Ohio territory, which is said to contain sulphur compounds in considerable quantity.

Nitrogen.—Natural gas, dried by calcium chloride and phosphorus pentoxide, was passed over strongly heated magnesium powder. The magnesium was partly converted into a nitrite, easily recognized by its reaction toward moisture, yielding ammonia in considerable amount.

Repeated trials have been made of natural gas in the following way:

A measured volume of gas was passed over ignited oxide of copper contained in a porcelain tube, the entire apparatus having been previously filled with pure carbon dioxide, which was caused to flow in a continuous stream for several hours in order to expel all traces of air. The escaping gas was collected in a eudiometer over mercury and the carbon dioxide absorbed by soda. There was left invariably a residue of gas unabsorbed by the soda and having no action upon palladium chloride solution. This residual gas was evidently nitrogen. (See Table of Analyses.) In the gas found in an artesian boring at Middlesborough, England, nitrogen was found in large proportion. (See Table of Analyses.)

Oxygen.—By the use of pyrogallol and soda, and by the oxidation of manganous hydrate in water, I have frequently been able to detect traces of oxygen, although on other occasions no oxygen could be found. It has only been recognized when the gas had bubbled continuously for many hours or days through the reagent. It cannot be said that oxygen is a constant constituent, although it does unquestionably occur in much of natural gas in minute traces.

Carbon Dioxide.—Carbon dioxide is present in all natural gas, as is easily proved by its action upon lime water.

Ammonia.—In the case of a gas well near Canonsburg, the following result was obtained: Gas was caused to bubble directly from the main at the well through water for several hours. On applying Nessler's reagent to the water, a feeble reaction was obtained. Ammonia was not found elsewhere in the trials I have made.

Mr. S. A. Ford, of the Edgar Thomson Steel Works, reports a very interesting case where masses of solid ammonium carbonate were blown out from a gas well by the pressure of the gas.

Natural gas appears to consist chiefly of methane, with traces of higher hydrocarbons of the paraffin series. Nitrogen is probably always present, together with a little carbon dioxide. The absence of free hydrogen, of olefines and of carbon monoxide, is, I believe, clearly shown in the case of the natural gas I have examined.

If natural gas as found in the well of any one gas region is derived from one vast subterranean reservoir, approximate uniformity in composition should be looked for. It is often noticed, however, that gas from adjacent wells possesses a different odor.

A carbon dioxide determination was made in the case of samples of gas from six wells near Tarentum, Pa. These wells were situated nearly on a straight line less than a mile in length. The samples were all taken within an interval of three hours.

The determinations were made by a 7 per cent. soda solution in an eudiometer over mercury.

Well.	Carbon Dioxide Per Cent.
No. 1	0·42
No. 2	1·25
No. 3	0·25
No. 4	1·47
No. 5	1·28
No. 6	1·28

The differences in the proportion of carbon dioxide, a constituent determinable with great precision, would be difficult to explain if the gas flowing from these different wells is derived from one subterranean reservoir.

(II) QUANTITATIVE ANALYSIS OF NATURAL GAS.

It is not possible to determine the proportion of the individual paraffins in a gas mixture by the Bunsen method of explosion of oxygen unless it can be positively asserted that only 2 paraffins occur. This may be readily shown by an example. If a mixture of one volume each of marsh gas, ethane and propane is burnt, the volumes of oxygen required, carbon dioxide and steam produced will be as follows:

	Oxygen Required vols.	CO_2 vols.	H_2O Vapor vols.
1 vol. methane	2	1	2
1 vol. ethane	3½	2	3
1 vol. propane	5	3	4
	10½	6	9

Three volumes of ethane require for combustion 10½ volumes of oxygen, and yield 6 volumes CO_2, and 9 volumes of steam.

Hence a mixture of 3 gaseous paraffins could not be distinguished, in the case of a volumetric analysis, from the intermediate paraffin. Moreover, the heat of combustion of 3 volumes of the intermediate paraffin is almost exactly equal to that of a mixture of one volume each of the three.

From the fact last stated it follows that, as regards the calorific value of a mixture of paraffins, an exact determination of the character of the individual paraffins is not required.

A saving of time, the possibility of using a larger volume of gas, the avoidance of a volumetric determination of water vapor, are some of the advantages gained by a combustion over copper oxide.

The application of gravimetric methods for the examination of gas is not new. Winkler ("Handbook of Technical Gas Analysis," p. 87) has described such a process for the analysis of mine gas.

Description of Method.—The process employed was, with some slight modifications, the same as described in the "Annual Report of the Geological Survey of Pennsylvania," for 1886.

Glass cylinders having stop cocks at both ends, accurately calibrated by mercury, and of 300–400 cubic centimeters capacity, were filled with natural gas. Where possible, this was done at the well. Before filling with gas, finely drawn out threads of glacial phosphoric acid were inserted through the stop cock into the vessel. After 24 hours the gas sample could be considered dry.

Glacial phosphoric acid, on softening in the flame, may be readily drawn out like glass into rods of almost hairlike fineness. The quantity required was not sufficient to cause error in the gas measurements, inasmuch as the gas, as it flows from the wells, is in most instances remarkably dry.

The cylinder was then connected with a porcelain combustion tube, C, containing copper oxide. The general arrangement of the apparatus is shown in the accompanying sketch.

Before the communication was made between the tube, C, and the glass cylinder, A, air was expelled from C by pure nitrogen dried in the tubes, M. The combustion tube was intensely heated during the passage of the nitrogen.

After expulsion of air by nitrogen, the natural gas was caused to flow over the copper oxide previously heated for some time. The movement of the gas through the combustion tube was controlled by means of mercury, which flowed from the funnel, D, into the gas cylinder, and was so regulated that 2 hours were required for complete combustion.

Experiments showed that there is no danger of production of carbon monoxide or unsaturated hydrocarbons when the gas stream is slow.

After the gas had been expelled from the cylinder, A, it was rinsed by lowering the mercury funnel so that nitrogen passed down into the cylinder, to be again driven out by raising the funnel.

After the gas had been fully burnt, air (purified by the lower system of drying tubes in the sketch) was passed through the apparatus till the nitrogen and moisture had been fully displaced and the process was then complete, the CO_2 and H_2O being determined by weight. The method, as is seen, gives merely the proportions of carbon and hydrogen.

As the exact percentage of the paraffins in the gas mixture cannot be ascertained by analysis, an approximation alone is possible.

The composition by weight of some of the lower (gaseous) paraffins is as follows:

Paraffins.	Carbon Per Cent.	Hydrogen Per Cent.
Methane	74·97	25·03
Ethane	79·96	20·04
Propane	81·78	18·22
Butane	82·72	16·28

In the following table the calculated composition by weight of various mixtures of methane and ethane is given (the atomic weight of carbon being 11·97):

Mixture of Methane Vols.	Mixture of Ethane Vols.	Carbon Per Cent.	Hydrogen Per Cent.
1	1	78·22	21·78
3	2	77·73	22·27
2	1	77·38	22·62
5	2	77·11	22·89
3	1	76·89	23·11
7	2	76·70	23·30
4	1	76·56	23·44
5	1	76·30	23·70
6	1	76·15	23·85
9	1	75·82	24·18

From a gravimetric analysis of natural gas, it is easy to determine the relative proportions by weight of carbon and hydrogen in unit volume, and from these the composition may be stated volumetrically in terms of ethane and methane, by the use of the preceding table, and with a fair approximation to the truth.

It is probable that minute quantities of propane and perhaps higher paraffins occur, but these cannot be identified. The nitrogen and carbon dioxide being determined, the volume of $CH_4 + C_2H_6 + C_3H_8 + \ldots$ is obtained as a difference. The error involved in such a method may then be exactly defined as follows:

The hydrocarbons may consist of methane with traces of propane or of methane with ethane or butane, but the analysis will be stated volumetrically in terms of methane and ethane only.

As regards the question of fuel value, I have endeavored to show (see "Report of Geological Survey of Pennsylvania," for 1886) that the above method will give closely approximate results when certain factors relating to available heat of combustion of paraffins are used.

The gravimetric method affords at the same time a means of control, for it is not only true that in a given volume of a particular paraffin, or of a mixture of paraffins, the hydrogen and carbon will occur in definite quantity, but the ratio $\frac{C}{H}$ is a constant and will be greater as the proportion of higher to lower paraffins is greater.

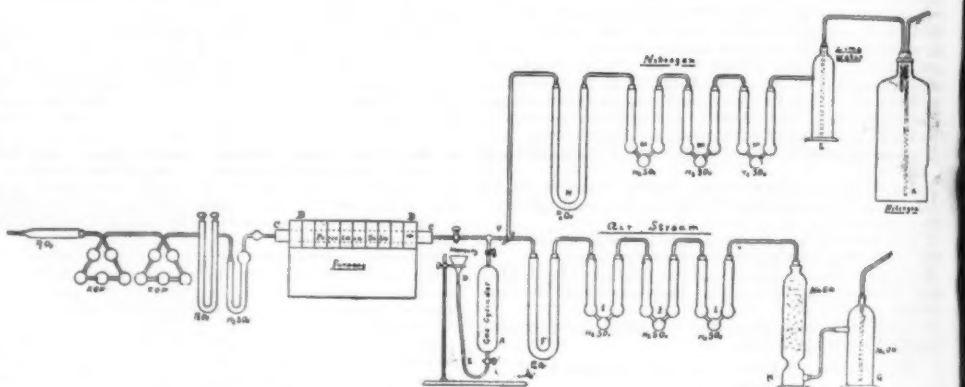
These considerations will serve to show the limits of accuracy of the method.

Nitrogen was determined by passing a measured volume (100 cubic centimeters) over ignited copper oxide contained in a porcelain tube, and then into a eudiometer containing soda solution. By means of a stream of carbon dioxide continued for several hours, the air was expelled from the apparatus previous to the combustion of the gas. In presence of large excess of carbon dioxide, combustion by copper oxide is greatly retarded, and the process must be conducted very slowly to effect complete oxidation.

Oxygen, as already stated, occurred in too small proportion to allow of a quantitative determination.

Carbon dioxide was determined by soda solution in a eudiometer over a mercury trough.

(*To be continued.*)



APPARATUS FOR QUANTITATIVE ANALYSIS OF NATURAL GAS.

DIFFRACTION.

AT a recent meeting of the Physical Society, London, Mr. W. B. Croft read a paper on some observations in diffraction, and exhibited a large number of photographs of diffraction figures obtained under different conditions. The first series exhibited, says *Nature*, related to diffraction from parallel light (diffraction of Fraunhofer and Schwerd), and were obtained by placing various combinations of thin circular lines of light on a dark glass plate before the object glass of a telescope focused on a star. Spectral images of the star are formed by interference from the edges of the lines, thus giving diffraction patterns whose form depends on the shape of the aperture employed.

The next series illustrated diffraction in shadow (Fresnel's diffraction), and were produced by condensing light on a minute pinhole, and placing the object between the hole and a microscope eyepiece. Beyond the eyepiece the camera used for photographing the phenomena was placed. Permanent records of remarkably good diffraction figures were obtained in this way, both of the combinations of circles above mentioned and of various other objects and geometrical forms. After showing geometrically that diffraction bands from narrow obstacles and openings were wider than those from broader ones, the author explained the conditions necessary for making the bands visible, and pointed out the distinction between internal and external bands.

Prominent among the photographs were several showing "Arago's white spot" at the middle of a shadow, and, in particular, this well-known phenomenon was shown as produced by so large an object as a threepenny piece. Speaking of diffraction in a microscope, the author said little doubt need exist as to

whether an image represented the real object or a diffraction modification thereof, for the latter were usually of a more misty and complicated character. Departing somewhat from the subject of diffraction, an excellent photograph of conically refracted pencils was shown, consisting of circular lines of light produced by passing light from pinholes through a crystal of arragonite. Dr. Johnstone Stoney thought the obtaining of permanent records of diffraction phenomena of great importance, and was particularly interested in the photograph showing conical refraction. Prof. S. P. Thompson said he had never seen diffraction effects exhibited to an audience so well before. He had noticed that in several of the photographs Arago's spot was unintentionally shown to perfection in the shadow of dust particles. The president greatly appreciated the fact that the conical refraction photograph had been exhibited for the first time before the Physical Society.

BRAIN AND MUSCLE.*

By Dr. WILLIAM A. HAMMOND.

IT was with great pleasure that I accepted the kind invitation of the president of your Alumni Association and the founder of this course of lectures, Gen. Butterfield, to address you on the important subject of the relations of physical exercise to the mind and body in some of the prominent occupations of the active man. It is not to be expected that I shall enter at length into the consideration of the anatomy, chemistry, and physiology of the subject; but there are a few prominent points in these connections which it is essential should be understood in order that you may fully appreciate the views which are to follow. For, though you may already have a general idea of the matters to which I refer, it will not, I am sure, be time thrown away if I endeavor to bring them specifically to your attention on the present occasion.

In order that a person may have the capacity for physical exercise, he must possess three kinds of anatomical organs—nerve centers to provide the force by which the muscles are to be made to contract, nerves to transmit this force, and muscles, by means of which the force is manifested in the movements of the body and limbs. All these organs, however, would be useless unless there is the force, to which I have referred, to put them in action, and this force is the mind. And by mind we are to understand, not only the force that comes from the brain, but that also which is evolved from other parts of the nervous apparatus, the spinal cord and certain collections of gray nerve tissue called ganglia, found in various parts of the body. Without this force the organs in question would be in about the situation of an engine without the steam required to set it in motion. The organism is complete, its cylinders, pistons, and valves are in order; but it is dead, for the force that makes it a thing of life is not there. Now this force in the animal body is produced by the action of what is called gray nerve substance. In the brain this is placed on the outside to the depth of about a twelfth of an inch, and is hence called the cortex; but in the spinal cord it is in the interior of the organ, extending its whole length, and being shaped something like a capital letter H. I used to say in my lectures to medical students that if I should ever be disposed to make for myself a god, I would select a piece of gray nerve tissue as the object of my adoration. For it is the most wonderful substance, so far as we know, in the whole universe, surpassing in its grandeur sun and moon and stars and everything else of which we have any knowledge. It is the substance that makes man what he is, that causes him to perceive, to experience emotions, to conceive ideas, to exert his will—in short, to evolve his mind. And though it is found in all animals, high and low, it is in none in such great quantity or in such a high state of elaboration as in that being who stands at the head of all animated nature.

But the gray nerve tissue forms but a small portion of the nerve substance of the brain and of the spinal cord. There is another which constitutes the greater part of both these organs, and this is the white substance. The nerves themselves consist entirely of this matter. It has nothing to do with the production of force. Its office is to receive impressions from without and to convey to the muscles and organs of the body the power by which their functions are performed. It places the gray substance with which it is in intimate contact in relation with the external world.

I have said that the brain is not the only organ which serves for the production of mind. If you have ever seen, as I have in the course of physiological investigations, a decapitated frog perform acts showing the possession of perception, intellect, and will, you would at once admit the correctness of my statement—a statement which is certainly not in accordance with the preconceived ideas of many of you, and which would possibly be called in question by some physiologists. If the side of such a frog be gently tickled with a straw, the foot of that side is at once used to push the straw away; if that foot be held so that it cannot be employed, the foot of the other side is brought into action to accomplish the purpose. If the animal be placed in a vessel of water, it swims almost as vigorously as if the brain were still in its proper place, and if it meets with an obstruction, it turns aside to avoid it, or if unsuccessful in the effort, ceases its swimming movements. All these efforts show intelligence and indicate that there are other sources of mind than the brain. I have seen a snake crawl to its hole, a distance of several feet, after its head had been cut off, showing that the knowledge it had acquired before mutilation was still present and available for the object in view. The tale of a turtle will vibrate if pinched for several months not only after the head of the animal is removed, but after the entire contents of the shell have been scooped out and made into soup for the delectation of a London alderman or a New York epicure. And in *The New York Sun* of a recent date I find an incident described which bears directly on the point under discussion. A sea turtle was captured by a party of gentlemen on the Gulf shore in Texas, and its head was cut off preparatory to the animal being cooked. Much, however, to the surprise of the party, the decapitated turtle endeavored to escape by making for the water. Several times it was turned around, but in every instance it discovered the direction in which the water lay and made efforts to reach it. The writer states that he has several times witnessed a repetition of the procedure, and calls attention to the fact that water snakes exhibit the like action when decapitated.

I call to mind how upon one occasion a rattlesnake behaved to a teamster who had cut off its head with a stroke of his whip lash. The snake remained coiled, and the man bent over it to examine the animal more closely. Suddenly the coil straightened, and the headless and bloody trunk struck the curious observer full in the forehead. The man fainted from the nervous shock, and the snake crawled away to hide under a sage bush.

These manifestations are not so striking in warm-blooded animals, but even in them they are not entirely absent. You have all probably seen a chicken, after its neck has been wrung, walk several steps in quite a determinate manner before falling and dying from loss of blood.

A man, however, without a head is not of much use, but this is mainly due to the fact that the act of decapitation necessarily involves the loss of such a large quantity of blood that the death of the whole body ensues almost at the very instant. Nevertheless, I can recall to your minds many examples in which while the brain, though present, is quiescent or otherwise engaged, actions are performed which can only be the result of some degree of mentality. Take for instance the fact (of which doubtless many of you have personal experience) that a young lady will engage her brain in conversation with her sweetheart while at the same time she performs a difficult piece of music on the piano. She cannot do this with a composition that she has not thoroughly learned, for then she requires all the mind that the brain and spinal cord can give her; but when the music is well mastered she can employ her brain with her young man and her spinal cord with her piano. You have all doubtless, while walking or reading, occupied your higher mental faculties with something very foreign to directing your steps in crossing streets or jumping gutters and turning corners until you reached your own doorsteps, or in paying attention to the novel you may be perusing or the abstruse volume on mathematics you are studying, and yet you have never made a mistake in your route or failed to turn over the leaves regularly as you reached the bottom of the pages without your having the slightest consciousness of what your legs have been doing in the one case or your hands in the other. No idea of the scenes that have been enacting before you, or of the incidents or problems of your books, has been formed. Your brain has been otherwise employed; your spinal cord has moved your legs and your hands.

The main point I wish to impress upon you in citing these facts is this—that there is a force that comes from the brain and that there is another, and a lower order of force, that comes mainly from the spinal cord. As a consequence there are two kinds of physical exercise—that to which the whole mind is given, and which is therefore active, spirited, determinate, conscious; and that into which the higher qualities of the mind do not enter, and which is, therefore, automatic, spiritless, and almost, if not entirely, merely mechanical. I simply mention these facts now in order to indicate the principles I desire to lay before you; but as they constitute the essential feature of my remarks, and are the basis of the advice I shall have to give you, I shall consider them at greater length when I have touched a little more fully upon some of the primary conditions associated with all physical exercise.

In order that force of any kind should be developed, matter of some description must undergo a change of form. To obtain steam and the force due to its expansion we ordinarily employ some highly carbonaceous substance, such as coal, wood or petroleum, by the combustion of which it is decomposed, heat is evolved, the water is raised in temperature, and steam is formed. To obtain the force known as galvanic electricity we can take a plate of carbon and one of zinc and immerse them in sulphuric acid diluted with water. The acid at once attacks the zinc, a new compound of sulphate of zinc is formed, the water is decomposed into its ultimate elements, and through this double action galvanism results and passes off by means of the attached conductors. Then it may in its turn decompose a solution of gold and gild a trinket, flash a telegraphic message to a distant part of the earth, aid the physician in the restoration of a paralyzed muscle or stimulate an optic nerve, the conducting power of which has been lost, and thus give back the eyesight that otherwise would never have returned.

This law that force results from decomposition of matter is just as absolute, so far as the nervous system of man and other animals is concerned, as it is in its relations to inorganic matter. With every thought, however trifling it may be, a certain amount of gray nerve tissue is decomposed, and the products of this destruction entering the blood are carried off by the skin, the lungs, the kidneys, and other excretory organs, and discharged from the system as effete material to enter into new combinations, and perhaps to reappear in the course of no very long period of time in the form of potatoes, or turkey, or beef, and again to be deposited as new gray nerve tissue. Thus the sequence of composition and decomposition continues while life lasts—yes, and after life has departed and the whole dead body returns to the earth from which it came.

And thus the change goes on, not only with every thought that is conceived, with every emotion that is felt, with every perception of sight, or hearing, or touch, or taste or smell that puts us in relation with the external world: with every act of the will, gray nerve substance is decomposed and new matter primarily derived from the food we take is deposited from the blood to take its place.

But this is not only true of the force-producing centers; it is equally a fact with the various organs of the body on which the force acts. Thus the liver secretes bile, and a portion of its substance is destroyed with every drop of the fluid that is produced; the heart beats to send the blood, which is to preserve life, to every part of the body, and with each throb a certain part of the cardiac substance dies: the tears flow, started by some overwhelming passion, and the glands which separate them from the blood weigh less after than before the emotion which put them in action is experienced; a finger is bent, a word is spoken, an eyelid trembles, and the muscles that acted to accomplish these results part with a portion of their fibers. These are not fanciful statements. They are based upon exact experiments and are not subjects on which physiologists differ. Thus I took the gastrocnemius muscle (the one forming the calf of the leg) of a recently killed frog, weighed it accurately on an extremely delicate balance, then hermetically inclosing it in a glass tube, also accurately weighed, and then connecting its nerves with the electrodes of a galvanic apparatus, caused it to contract rapidly until its irritability was altogether lost. Then removing it from the tube, I weighed it again and found that it had very appreciably lost weight.

The fact that physical exercise diminishes the weight of the body you can establish for yourselves by a very simple but perfectly conclusive process. Weigh yourselves on a delicate balance, then exercise strongly for an hour or so and weigh yourselves again. You will find in every case that you have lost weight. Of course there would be some loss owing to the exhalations from the lungs and skin, but the extent of this can be determined by weighing again after a like period of time has elapsed, during which the body has been kept in a state of quiescence.

Several years ago, when I was more enthusiastic in such matters than I am now, I performed upon myself a series of experiments for the purpose of ascertaining the effects upon the body of rest and mental and physical exertion, and as these have a direct bearing on the subject of my remarks, perhaps you will allow me, if I promise to describe them in non-technical language, to quote some of the results to you.

I found from these observations, continued over a period of ten days, that the average weight of the body, as determined upon a balance capable of turning with the hundredth of a pound, was 196·33. I then (the food and all other factors remaining exactly the same) endeavored to ascertain the effects of what to me was unusual physical exercise. This consisted of the lifting of a weight of one hundred pounds ten feet in a minute for three periods of fifteen minutes each at intervals of an hour. This course was continued, as in the standard series of experiments, for ten days. The body was weighed every day, and the average showed 194·13, a loss of 2·20 pounds. Thus the nerve center originates the force by which a muscle is made to contract. A nerve transmits this force to the muscle and the action ensues. In no essential respect is the process different from that in the sending of a telegraphic message. The battery supplies the electricity, a wire carries it to the recording instrument, and the act is accomplished.

All this will serve to give you an idea of the mechanism of physical exercise and of some of the consequences of muscular contraction pure and simple without the interference of any disturbing factor. But did you ever notice in your own experience what a very stupid thing physical exercise, for the mere sake of exercise, is? If you want to see the weariness, the utter despair, excited by this kind of exertion, look at a dog who is turning the wheel of a churn. Or, better still (though perhaps you would experience a difficulty in finding examples in this country), study the faces of the men who are working a treadmill. Apathy, disgust, the sluggish will barely exciting the still more sluggish muscles, the facial expression scarcely more eloquent in expressing mental exhaustion than are the bowed back and semi-flexed limbs indicative of the loss of muscular energy. And if you want a still more striking picture of the degradation of objectless physical labor, look over the earlier pages of Charles Reade's novel "Never Too Late to Mend."

I remember when in the first years of my military experience I was stationed as a medical officer at the little New Mexican village of Cebolleta. A favorite punishment of the commanding officer, when the soldier's offense was not so grave as to require a court martial, was to cause him to carry stones from one pile to another, a distance of perhaps fifty feet, and when the one was exhausted and the other piled up, to carry them back again, and thus to continue for a period, according to the nature of the breach of discipline he had committed. Nothing was so much dreaded by the men as this punishment; they would have preferred almost anything else. Bread and water for a week, deprivation of liberty, stoppage of pay, even "bucking and gagging," were less unpleasant to them. And yet it was physical exercise, not cruel, not even severe, but painful from its monotony and objectless character.

I have, as have also many of the patients who have come under my professional care, made repeated conscientious attempts to do a certain amount of systematic muscular exercise every day. We have struggled with Indian clubs, dumbbells, lifting machines, and many other contrivances warranted by their inventors to bring every muscle of the body into action; but it has been weary work, and has been rarely carried on for longer than a few weeks. In my own case I know of nothing more stupid, tiresome, tedious, fatiguing, irksome, than such exertion. It leaves the mind and the body in a state approaching collapse, and one half hour of it is more exhausting than a whole day spent in hunting, or in some such exercise affording mental stimulus. It always seems to me that it is just so much time thrown away, for we cannot even think when we are swinging an Indian club or putting up a dumbbell. So far as any influence upon mental or physical well-being is concerned, I could never see that it was of the slightest service. In fact, it has always been to me and to many others whose experience has come to my knowledge an unmitigated nuisance.

Even walking in the open air without having some definite object in view, or something entertaining in the surroundings, acting as a stimulus to the mind, is a more or less wearisome business. But a promenade down Fifth Avenue or Broadway, where the houses, the people, the equipages, the shop windows, and the varied incidents necessarily resulting from crowded streets give a constant succession of mental excitations, is quite another thing, and one returns from such a walk with the body invigorated and with the mind in a state of elasticity and contentment that nothing else in the whole course of my experience with physical exercise can surpass. If a sudden demand be made for

* An address before the Faculty and Students of Union College, at Schenectady, N. Y., on Feb. 9. From the *New York Sun*.

an undue exertion of muscular power, or if some intense mental effort be required, both body and mind are ready for their work, which is performed with a degree of readiness and thoroughness that mere physical exercise without the mental interest could never effect.

In this lie the many differences that exist between the exercise of the person who takes it solitary, perhaps in his bedroom or in a gloomy gymnasium, and one who with some other object in view than that of stretching his legs or contorting his body brings into action both his mind and his muscles in the open air while walking through the ever-changing streets of the city, with a thousand objects of interest around him, or taking a tramp through a region of country new to him, with its varying scenes of mountain and stream and forest, and inhaling such air as can only be had away from the crowded haunts of man. I am not quite sure, however, but that there is more diversion and more recreation (and I stop for the moment to call your attention to these two words, "diversion" and "recreation") in Fifth Avenue than there is in the Adirondacks or the Rocky Mountains. I have tried them both very thoroughly, and I think I have a right to speak with some degree of positiveness on this point. However, this is, after all, a matter of taste and education; but as for me, I confess to liking houses and men and women better than I do trees and chickens and cows.

But after all, nothing is more desirable in the way of muscular exertion than to engage in some athletic contest, that not only draws upon the body for all its muscular tact and vigor, but that also calls into exercise the faculties of the mind in all their categories of perception, intellect, emotion, and will.

The ancient Greeks and Romans well understood the facts upon which I have laid stress. They thoroughly knew the advantages of mental stimulation as the accompaniment of physical exercise, and hence their youths were encouraged to enter into contests with each other for supremacy in running, wrestling, throwing the discus, or boxing with the cestus. Every prize fighter knows that he is more fatigued after an hour's contest with a dummy in the shape of a hollow rubber ball or a cushion of some kind than he is after a standup fight with the gloves for the same period with an active antagonist against whom he is obliged to employ not only his muscles in all their activity and strength, but his perceptions in their utmost acuteness, his intellectual faculties in some of their most highly developed forms, his emotions to spur him on in the hope for victory, and his will to set his muscular mechanism in action and to cause it to functionate with its most intense degree of agility and power.

Exercise, for the mere sake of exercise, is to many persons the very quintessence of weariness, and it is impossible to believe that it can in such cases be productive of the maximum of benefit which muscular exertion is capable of affording. Fatigue ensues much more quickly and is more pronounced than when the mind is exercised simultaneously with the body. A young woman will go through an amount of muscular exercise in a ballroom that would be impossible for her in the performance of some laborious task in which she took no pleasure. I have no doubt that some of you have experienced like results after rowing in a sham boat in the gymnasium and a spirited contest on the Mohawk with a man rowing against you, and thus calling into exercise all the ambition, the judgment, the firmness, the will power, that the gray nerve substance of your cerebral cortex could evolve.

And then on the ball field what a splendid arena there is for the exercise, not only of all the physical strength and endurance you possess, but also of those higher mental faculties that such rivalry will always call forth in an American youth, and in the exercise of which he fits himself for the struggle that is before him! That is the kind of exercise that the professional man and the scholar require.

I am quite sure that there is a variety of physical exercise which is not practiced as much in this country as it ought to be, and which of all others stands preeminent as the kind most efficacious in developing the muscles, and at the same time calling into action those mental faculties, the degree of development of which makes the difference between the man of strong and noble mind and the one of feeble and mean mentality. I refer to fencing. It is pre-eminently an exercise of the mind and body, one that requires in the highest degree not only strength but activity and quickness of movement, while at the same time the mind, in all its faculties, is kept alert, not only so far as attack is concerned, but in studying every muscular movement and every idea of the adversary, so as to anticipate his intended onslaughts before he can make them.

It has been well said by a recent writer on fencing that "the beneficial effects of moderate fencing to persons of weak constitutions, or of studious and sedentary habits, have been attested by medical practitioners of the first eminence. To the public speaker the practice of the fencing room has been found to impart an ease and freedom of gesture attainable by no other exercise. For, while the use of the foil and the broadsword diffuses ease, elegance, and grace all over the body, and imparts to the look and gesture an appearance of intellectual vigor, it teaches invaluable lessons of patience and self-command, and contributes to discipline the temper. 'Perhaps there is no exercise whatever,' says Mr. Roland (Theory and Practice of Fencing), 'more calculated for these purposes (developing and cultivating bodily strength and activity) than fencing. Riding, walking, sparring, wrestling, running, and pitching the bar are all of them certainly highly beneficial; but beyond all question, there is no single exercise which combines so many advantages as fencing. By it the muscles of every part of the body are brought into play; it expands the chest and occasions an equal distribution of the blood and other circulating fluids through the whole system. More than one case has fallen under the author's own observation, in which affections of the lungs and a tendency to consumption have been entirely removed by occasional practice with the foil.'"

The will travels through a nerve to a muscle at the rate of about seventy feet in a second. A muscle cannot move at a rate of speed the one-tenth part of this. We conceive an idea and exert a volitional impulse upon an arm, for instance, much quicker, therefore, than we can obey the command and move the limb. In fencing, and, indeed, to a less extent, in all athletic contests, those who can form a correct idea of the purposes of their adversaries, who can send the will through their nerves with the greatest rapidity, and whose muscles obey their behests with most promptitude and power, will be the winners. Is it not, therefore, apparent that such exercises train both mind and body for the battles of life, and that it is not unreasonable to assert that, other things being equal, the best fencer or ball player will carry off the most prizes when he contends for scholarly, professional, or business success?

Mere physical exercise cannot of itself prepare a man for any higher position in the social scale than that of "a hewer of wood and a drawer of water" for him who knows how to use his brain. Those who spend their early lives in physical labor, and rise to high estate, do so in spite of their muscles. The brain asserts its superiority, and muscularity is relegated to the background. Lifting heavy weights, following a plow, or breaking stone, does not develop the brain. Such occupations enlarge the muscles and increase their strength, but the professional man or the scholar does not expect to make his mark in the world by his muscular power. It is his brain that is to be strengthened, and his muscles require no more exercise than is sufficient to keep them in a healthy state of repair, to preserve them from rusting, as it were; and this they get in the daily routine of normal life without any special means being taken to procure it.

I think that a daily walk of three or four miles in the open air at the rate of about three miles an hour, with such swinging of the arms as nature has provided for in arranging the gait of man, is sufficient. If this is taken on a gymnasium track, or in an inclosed and artifically heated piazza, it will lose some of its good effects, but will still serve the purpose of promoting that metamorphosis of muscular tissue—that removal of old substance and the deposit of new to take its place, which it, in common with all the other structures of the body, requires for its well being.

But the man who uses up his nerve force in producing muscular contractions runs the risk of not having enough for the other requirements of the system. In such circumstances a condition exists which may be well represented by the simile of the man who has steam power to let. Some of it goes to a silversmith, we will say, some to a printer, some to a miller, some to a man who has an office building with elevators in it. Now, if the silversmith uses up more steam power than his due proportion, all the others suffer. The printer cannot print his books, or the miller grind his grist, and the elevators refuse to budge. So it is with man. Excessive use of nerve force in one direction causes imperfect action in other organs; the heart beats feebly and irregularly; the gastric juice not being secreted in sufficient quantity, leads to dyspepsia; the brain, giving an undue amount of nerve force to the muscles, has not enough for its higher functions, and thus it is that those athletic men who make athletic exercises the main object of their lives are rarely, if ever, noted for great intellectual power. The ancients recognized this fact, and hence Samson, the strong man of the Bible, and Hercules, the athlete of profane history, were poor, simple-minded fellows, easily imposed upon, and, like most other amiable men (men, not women; all women should be amiable), deficient in mental vigor.

It is a matter of daily experience that when the muscles are exercised beyond the point to which they are accustomed, a sensation of fatigue is felt, which becomes more intense, and even painful, if the exertion be continued. Make the experiment of trying to hold out your arm at a right angle to the body for five minutes, and if you have not habituated yourself to this effort, you will obtain a very clear idea of muscular fatigue. In such an action the deltoid muscle, which forms the rotundity of the shoulder, is the one mainly brought into use, and it is here that the pain is chiefly felt. What is the cause of this pain? Is it the direct result of the contraction of the muscular fibers? In a word, is muscular fatigue produced solely by muscular contraction, or is there some other factor acting as a causative agent? If solely and immediately due to the action of the muscles, why do we not always feel it when we have exercised them to an extreme degree? Recent investigations go to show that there is another cause, and that is that the muscles, in contracting, suffer, as we have seen, a certain amount of destruction; lower grades of substances result, and some of these are poisonous, and acting upon the muscles before the blood has time to carry them to the excretory organs of the body, exercised a poisonous effect and give rise to that sense of painful fatigue which we all know so well.

Such poisonous substances are produced in the life course of every person through the action of the several organs of the body, and if not promptly removed from the system, lead to the development of one or more of those diseases by auto-infection which have just begun to be studied, and which are of such surpassing interest to the physician. Now, it is scarcely a matter for doubt that when muscular exercise is carried on with disgust, or at least without pleasure, these poisonous agents are formed in great abundance and removed with less celerity than when the mind co-operates with the body to give zest and interest to the work. The convict laboring at the crank, or on the treadmill, readily breaks down, and perhaps dies, poisoned by the excretions from his own muscles. Ought not such facts to have their weight with social economists in their search for the best methods not only of punishing, but of reforming criminals? And when they are sufficiently recognized by the medical profession and the public, we shall hear less of so-called neurasthenia and nervous prostration, and very much less of that terrific insomnia with which so many brain workers are afflicted; for the brain, like the muscles, has its diseases produced by overwork.

And now, my friends, I must bring these imperfect remarks to a close, though there are other important features of the subject that, were there time, might well engage our attention. But I cannot end without requesting you to bear in mind that I am no enemy of proper physical exercise. I am, however, opposed to the apotheosis of muscle at the expense of brain. A man cannot be great in two opposite directions. There is no instance on record of a great athlete being at the same time a great scholar or professional man. We do not go to the Corbetts, the Mitchells, or the Sullivans for the presidents of our colleges, for our eloquent preachers, our learned jurists, our wise physicians, our skillful and gallant generals or admirals. The mental force of man has its limit of quantity, and no one, strive as he may, can exhaust it in physical labor and yet have enough left with which to achieve mental greatness. If I have succeeded in impressing this fact upon your minds, and in pointing out to you what kind of muscular exercise is best, I shall feel that I have been of some service to you, and that my friend did not err when he asked me to participate in the course of lectures he has so worthily established.

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